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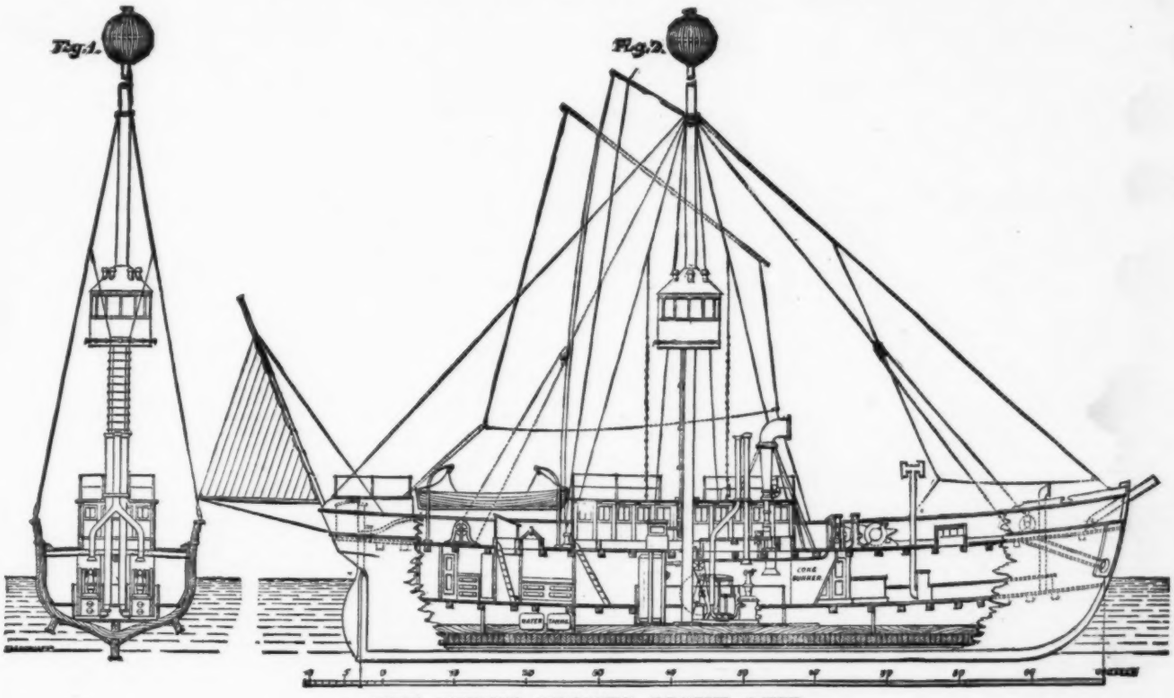
THE SEVEN STONES LIGHT VESSEL.

WE reproduce on the present page, by permission of the Institution of Civil Engineers, the engravings of a light vessel moored off the Land's End, the description of which formed the subject of a paper contributed by Mr. J. N. Douglass to the Transactions of the Institution. Of this paper the following is a summary: The "Seven Stones" are a cluster of dangerous rocks lying between Scilly and the Land's End, with only small portions uncovered at low water. They are exposed to the full fury of the Atlantic, and the erection of a lighthouse upon them would be a tedious and costly undertaking. In 1841 a light vessel was moored about 1½ miles eastward of the rocks, in 42 fathoms, and, as may be supposed, is subject to heavy seas during westerly gales. Her moorings consist of a 40 cwt. mushroom anchor and 315 fathoms of 1½ in. unstudded chain cable. In 1871 the vessel was provided with a "Holmes" fog trumpet, worked by a 1½ horse power "Ericsson" caloric engine, and until 1879 two fixed catoptric lights were exhibited on separate masts, 20 ft. and 38 ft. above the sea. In 1878 the Trinity House decided upon making several important improvements both in the light and the vessel itself, which, as it is now arranged, we illustrate. The hull is of timber, copper fastened throughout, and sheathed with Muntz metal. The hull is 103 ft. between perpendiculars, 21 ft. 3 in. in extreme width, and the depth of the hold, from the strake next the timbers to the upper side of the upper deck beams, is 10 ft. 3 in. In the event of the vessel breaking adrift she is provided with foresail, lug mainsail, and mizzen, the latter being frequently used with advantage for steadying the vessel at her moorings. The illuminating apparatus is of the catoptric group-flashing-light class, giving three flashes in quick succession at intervals of one minute, and consists of nine gimbaled Argand lamps, and paraboloidal reflectors of silvered copper, 21 in. in diameter. The lamps and reflectors are arranged on a turntable in the lantern, in three groups of three each, and are caused to rotate by clockwork at a speed of one revolution per minute. The intensity of the flashes is equal to about 8,600 standard candles, and about 7½ times the intensity of the old fixed lights, with only three-eighths the consumption of oil. The lantern is cylindrical, 8 ft. in diameter, constructed of wrought iron, and glazed with curved plate glass. It is fitted with doors fore and aft, for access from chain ladders suspended from the mast, and is large enough for the proper manipulation of the lamps during the night, without the necessity of lowering. The actuating clockwork is fixed in the deck house, and is driven by a pitch chain and weights descending in a trunk to the keelson; motion is transmitted to the catoptric apparatus by a light vertical shaft fixed on the aft side of the mast. In the day the lantern is lowered on to the roof of the deck house. The Holmes self acting siren for signal is arranged for giving three blasts in quick succession at intervals of two minutes; the motive power consists of a pair of Brown's caloric engines, each of five effective horse power, arranged for working singly or together. The engines are fitted with air pumps for supplying two compressed air vessels, from which the siren is sounded at a pressure of 40 lb. per square inch. The blasts are regulated by cams worked from the engines. The fuel consumed is locomotive coke, and the consumption is 18 lb. per hour per engine. The cost of the vessel—which was designed by Mr. B. Waymouth, secretary to Lloyd's—fully equipped for sea, with illuminating and fog-signal apparatus complete, was about £9,500.—*Engineering.*

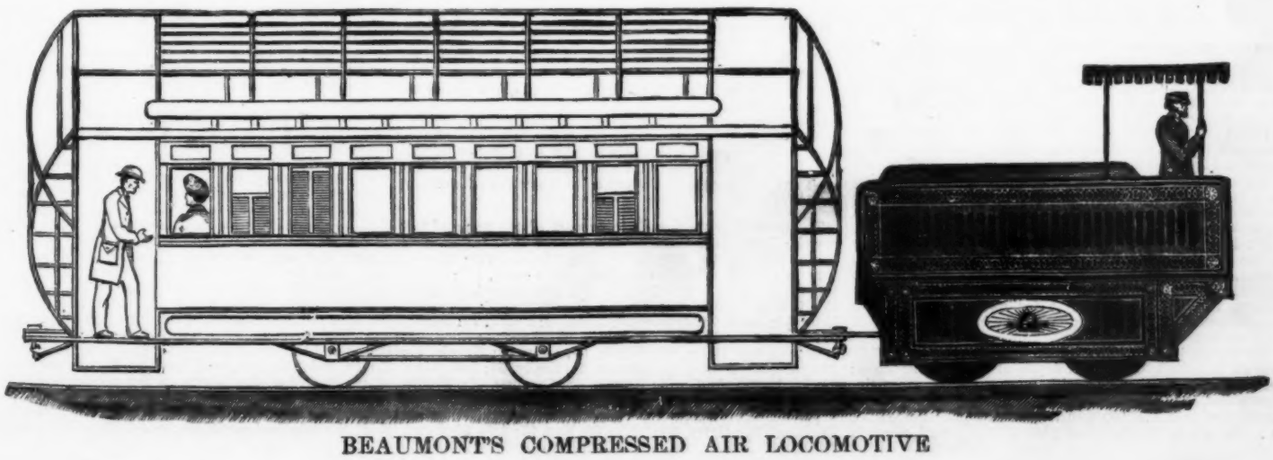


THE SEVEN STONES LIGHT SHIP.

COMPRESSED AIR LOCOMOTIVE.

THE great advantages that would result from the possession of a motor that is at once smokeless, steamless, and noiseless, that may be started and stopped at any moment, be free from the risk of fire or explosion, and be cheaper than the ordinary motors in use, are sufficiently obvious without our dwelling upon them. Besides their eminent suitability for tramways and traction on ordinary roads, they would be especially adapted also for launches, for the omnibus traffic of underground and suburban railways, for domestic purposes, and for amateurs and small industries. The inventor of the motor we illustrate herewith, Colonel Beaumont, R.E., claims not only the advantages we have indicated above, but further, that for traction purposes it complies with the requirements of the Board of Trade, that its weight may be made proportionate to its duty, that it can attain the speed of ordinary locomotives, and may accomplish all that can be done with any existing engine.

The invention consists principally in providing a suitable receptacle or vessel in which highly compressed air may be stored for use, and a motor or engine for converting the pressure into motion. There are several minor accessories,



BEAUMONT'S COMPRESSED AIR LOCOMOTIVE

among which we may mention a small steam generator which is concealed from view, the purpose of which is to provide means for preventing the too rapid cooling which would otherwise take place. As our readers are aware, atmospheric air, on being released from compression, very rapidly absorbs heat from surrounding bodies, and it is to supply the heat which would otherwise be abstracted from the cylinders of the engine that this steam generator is provided. So effectually does it do its work that the liberated air escapes from the engine at a temperature higher than that of the surrounding atmosphere, and without noise. Were it not for this device the lubricants used would be congealed, and the engine itself come to a standstill because of the ports and passages becoming filled with ice, resulting from the freezing of the moisture contained in the air. This steam generator is analogous to the boilers used for heating greenhouses and other places, and, like them, it is provided with two pipes, one for the outflow of the steam, and the other for the return of the steam after it has done its work in heating the motor and has been thereby condensed. Thus there is no escape of the steam into the air, but simply a circulation of it through suitable pipes and chambers around the motor.

In working, the air reservoir is charged at the beginning of the journey with air at a pressure of 1,000 lb. per square inch. This may appear to be an enormous and dangerous pressure, but, as a matter of fact, pressures very much greater than this can be employed with absolute safety. This highly-compressed air is first applied in a small cylinder, in which it expands, and the expanded air, still under a relatively high pressure, then passes to a second and larger cylinder, in which a further expansion takes place. This feature of the engine presents a twofold advantage. Thus, by turning the high-pressure air directly into the larger cylinder instead of into the initial small one, a large amount of power is developed to overcome any particular resistance, as, for example, in starting. The resistance having been overcome, the high-pressure air is shut off from the second cylinder, and diverted into its normal course through the first cylinder. Again, it will be obvious that, after the engine has been running for some time, the pressure in the reservoir will have become so much reduced as to be incapable of operating the motor. In this case, as in the one already cited, the first cylinder is, as our electrical friends term it, "cut out," and the compressed air passes direct to the second cylinder. The piston of this cylinder having a greater area, the same amount of power is developed with a lower pressure.

Another feature of the invention is of such a character as to make its necessity patent to all. If, in running the engine, we start with an initial pressure of 1,000 lb. on the square inch, it is clear that we shall quickly reach a pressure of 900 lb., less quickly 800 lb., and still less quickly 700 lb., and so on. If no provision were made for controlling the quantity of air used per stroke of the motor, it is obvious that the speed would gradually become slower with the reduction of pressure. Such a provision has been made, and it is found to answer its purpose so well that no variation in the constancy of the power or speed of the engine occurs within the wide limits included between 1,000 lb. and 200 lb. per square inch. Below this pressure the first cylinder is disconnected, as already mentioned.

The reservoir can be replenished with compressed air in a very short time, less, it is said, than is occupied in changing horses or in filling a tender. The engines employed in compressing air are of the best stationary type, and require far less fuel per indicated horse power than is required for a locomotive or tram motor. Hence it arises that, notwithstanding the loss of power involved in compressing air, more power is developed per pound of fuel by Colonel Beaumont's plan than by the customary practice.

With reference to the distance which can be traversed at speed with one of these motors, a trial is reported at pages 310 and 311 of our issue of the 16th Oct., from which it will be seen that the journey on the North Kent Railway from Woolwich to Dartford and back, a distance of sixteen miles, was accomplished at an average speed of something like sixteen miles an hour. The pressure at the end of the journey was 80 lb. per square inch, but shunting at Dartford had reduced the pressure from 540 lb. to 510 lb. per inch; and we may therefore assume that this distance represents something like the length of journey attainable at present, and which is amply sufficient. Should occasion arise, however, there is no difficulty in constructing a motor on Colonel Beaumont's plan which shall be able to run much greater distances.

We hope the time is not far distant when our insular prejudice against superseding horses will be uprooted, and the consciences of the community be clear of the at present too-well-founded charge of aiding and abetting in the practice of gross and unnecessary cruelty to animals. We can speak from personal experience that there is nothing whatever to prevent the immediate adoption of this motor on all our tram lines, and for the 'bus traffic of railways, save certain fusty acts of Parliament and still more fusty prejudices. We think that horses and cattle rather like them than otherwise, as we have never seen a single animal show any sign of fear, and very little of curiosity, in their presence, thus manifesting a larger amount of common sense than their owners.—*Design and Work.*

NEW RIVER STEAMER.

OPENING OF THE RIVER WAIKATO TO STEAM NAVIGATION IN NEW ZEALAND.

A RIVER STEAMER lately built in New Zealand to the order of J. C. Firth, of Auckland, deserves especial notice, she having proved a complete success.

The vessel had to be constructed under peculiar circumstances. The entrance of the river being about fifty miles distant by sea from Auckland, it was requisite the vessel should be a seagoing one, and at the same time adapted for plying on a very shallow, narrow, crooked, and rapid river, one hundred and fifty miles long, about one hundred of which might be made available for navigation.

Mr. Firth decided to have a steamer built of iron as large as the river would admit, and to be propelled by twin screws, the river being too narrow to allow side wheels to be used, as they would wash the banks down, and thereby shallow the river and spoil it for navigation. A stern wheeler would not do on account of the rough sea part of the journey.

The dimensions of the vessel are 82 ft. long on keel, 87 ft. over all, and 20 ft. beam, 6 ft. depth of hold in the clear; her frames are $2\times2\times\frac{1}{4}$ in., with reverse angles; same size floor plates, $9\times\frac{1}{4}$ in.; deck beams, $2\frac{1}{2}\times2\times\frac{1}{4}$ in., one to each frame; keelson's T, $6\times6\times\frac{3}{4}$ in.; sister keelson's T, $4\frac{1}{2}\times4\frac{1}{2}\times\frac{5}{8}$ in.; the whole length, keel plates, bilges, and stronger plates are $\frac{1}{2}$ in. thick; all other plates are $\frac{7}{16}$ in. thick, divided into four water tight compartments, carrying thirty tons dead weight cargo on a draught of 2 ft. 7 in., and seventy tons on a draught of 4 ft.

The engines consist of two pair of 8 in. diameter high pressure cylinders, driven by a marine boiler 6 ft. 6 in. diameter; 10 ft. long return tubes, with a pressure of 75 lb. per square inch. The vessel is also fitted with a powerful steam winch for the purpose of hoisting cargo out of the hold fore and aft, and for holding her up over some of the rapids, of which there are several in the river.

After she had been running for a few months it was found that with very little more screw power she would be able to run the rapids without the assistance of a line. Mr. Firth had a third screw fitted in the center between the two, which answered the purpose admirably.

The river is the only road whereby Mr. Firth can carry goods to and produce from his large estate economically. But before that could be done a great deal of energy and capital had to be spent.

First. The native difficulty had to be overcome. The river runs through a large portion of native territory, and they did not wish to see the white man running steamers there, and objected to have the snags and rocks removed, as they said they did not like to see the new things of the white man coming among them, and that the snags were there when their grandfathers were boys, and should therefore remain. But this, considered the worst difficulty, was overcome as well as many others.

Second. The snagging of the river. For this purpose a small steamer and a punt were built, with all the proper appliances for blasting the snags by dynamite, and removing them out of the river.

Third. The rapids. Some of these were considerably reduced by blasting out the rocks, and removing sand bars, by constructing groins and diverting the current.

The whole of this work, about seventy miles, has been most successfully done by the self-reliant and public spirited efforts of Mr. Firth, and at his own expense, at a cost of about £10,000, without asking the government for any assistance. Thereby the public have got a highway opened for them free of expense to the county.

At Stanley, the head of the navigation, Mr. Firth has built large receiving stores, with all the modern appliances for loading and unloading.

The estate of Mata Mota commences here, and extends for twenty-five miles to the Waikato river. 10,000 acres, or about ten per cent. of the whole, has been brought under cultivation, and bids fair to be the great wheat-producing district of the North. There also Mr. Firth has all the most modern appliances and labor-saving machines, such as traction engines, steam thrashers, reaping and binding machines, etc.

THE "KOTUKU."

The steamer above described has been designed by Mr. James Lindsay, Managing Director of the Waikato Steam Navigation Company, and was constructed under his superintendence. She answers the purpose admirably, and has given great satisfaction to her owner.

NAMES OF VESSELS.

THE twelfth annual list of merchant vessels of the United States, with their official numbers and signal letters, together with lists and distinguishing signal letters of vessels of the United States Navy, Revenue Marine, Lighthouse Board, and Coast Survey, for the fiscal year ended June 30, 1880, has just been published by the Bureau of Statistics. It makes a volume of 411 pages.

According to a reckoning made by your correspondent the number of the different classes of vessels named in the lists is as follows:

Merchant sailing vessels	16,080
Merchant steam vessels	4,626
Unrigged vessels	2,352
Total	23,058

Of this number there are 3,785 classified as seagoing vessels.

In addition to the above there are the following vessels belonging to the United States Government:

Navy vessels	141
Revenue marine vessels	37
Lighthouse Board vessels	27
Coast Survey vessels	25
Total	230

The total number of vessels of every description flying the American flag is 23,288.

Of the naval vessels of first rate, 13 in number, 6 are on the stocks or laid up.

Of the 20 vessels of second rate 7 are on the stocks, laid up or in course of repair.

Of the 27 vessels of third rate 12 are on the stocks, laid up, or in course of repair.

Of the 22 wooden sailing vessels 4 are on the stocks or laid up.

Of the 24 ironclads 6 are on the stocks, laid up, or in course of repair.

There is a sort of indefinable fascination in the names of vessels. Many persons will doubtless be more or less interested in the analysis given below. An examination of the list of 23,000 vessels of the United States shows that the most frequent names of the vessels in the order of number are as follows:

The word Mary is the whole or part of the name of 635 vessels; John, 543; William, 499; George, 315; James, 283; Sarah, 192; Charles, 187; Annie, 177; Thomas, 176; Henry, 151; Emma, 151; Lizzie, 126; Ida, 123; Joseph, 116; Anna, 116; Alice, 110; Robert, 104; Nellie, 100; Samuel, 98; Ella, 95; Kate, 94; Carrie, 94; Maggie, 91; Hattie, 87; Clara, 84; Belle, 77; Julia, 76; Jennie, 76; Eliza, 73; Frank, 72; David, 69; Minnie, 69; Martha, 68; Laura, 66; Ann, 63; Ellen, 61; Elizabeth, 60; Helen, 60; Willie, 60; Lucy, 57; Fannie, 57; Florence, 55; Daniel, 55; Edward, 54; Emily, 54; Josephine, 54; Louise, 52; Addie, 51; Harriet, 48; Caroline, 47; Margaret, 47; Maria, 46; Flora, 44; Francis, 42; Virginia, 42; Cora, 41; Rebecca, 41; Benjamin, 40; Fred, 39; Richard, 39; Sallie, 39; Susan, 38; Harry, 38; Lillie, 38; Eva, 37; Ada, 36; Isaac, 36; Amelia, 35; Fanny, 32; Stephen, 32; Edith, 31; Lottie, 30; Lydia, 30; Nettie, 30; Agnes, 28; Edwin 27; Jane, 21; Hannah, 25; Andrew, 25; Franklin, 25; Lewis, 25; Jessie, 24; Marion, 24; Henrietta, 22; Catharine, 21; Jesse, 20; Frances, 20; Daisy, 19; Cornelia, 18; Charlotte, 18; Abbie, 18; Maud, 17; Adeline, 17; Lilly, 17; Bessie, 16; Etta, 16; Lena, 16; Isabella, 15; Ruth, 14; Irene, 13; Lillian, 12; Effie, 12; Emeline, 11; Georgiana, 11; Eddie, 11; Abbie, 10; Adelaide, 10; Gertrude, 10; Gracie, 10; Minerva, 10; Sophia, 10.

Of the 23,000 vessels 11 are named Advance, 17 Alaska, 18 Alert, 13 Ariel, 13 Arrow, 15 Banner, 8 Billow, 11 Breeze, 28 Centennial, 26 Champion, 24 Columbia, 24 Comet, 15 Commerce, 12 Constitution, 9 Dart, 12 Dauntless, 16 Delaware, 28 Dolphin, 9 Dove, 16 Dreadnaught, 24 Eagle, 15 Eclipse, 14 Empire, 28 Enterprise, 16 Eureka, 8 Excelsior, 13 Exchange, 18 Express, 12 Falcon, 12 Fashion, 22 Favorite, 16 Fearless, 13 Fleetwing, 12 Flying Cloud, 8 Flying Scud, 8 Four Brothers, 4 Four Sisters, 7 Garibaldi, 17 Gazelle, 13 General Grant and 9 U. S. Grant, 4 General McClellan, 4 General Scott, 4 General Taylor, 3 General Jackson, 2 General Washington, 5 George Washington, 18 Washington, 17 Gipsy, 13 Glide, 8 Golden Gate, 13 Golden Rule, 10 Gray Eagle, 14 Gray Hound, 10 Haze, 11 Hero, 26 Hope, 12 Hornet, 15 Hunter, 9 Idlewild, 12 Independence, 16 Industry, 9 Jenny Lind, 10 Lady of the Lake, 16 Leader, 13 Liberty, 10 Lone Star, 10 Lookout, 16 Magnolia, 6 Maid of the Mist, 24 May Flower, 13 May Queen, 8 Mermaid, 10 Minerva, 15 Minnehaha, 18 Mist, 18 Monitor, 10 Morning Light, 23 Morning Star, 11 Native, 13 Nautilus, 14 Neptune, 12 New York, 11 North Star, 10 Northern Light, 7 Ocean Wave, 11 Ohio, 16 Onward, 11 Oregon, 8 Oriental, 11 Ospray, 5 Palestine, 5 Palmetto, 7 Paragon, 7 Patriot, 25 Pearl, 12 Peerless, 10 Pennsylvania, 16 Petrel, 10 Phantom, 18 Pioneer, 11 Planet, 16 Quickstep, 8 Rainbow, 10 Rambler, 18 Reindeer, 11 Republic, 13 Rescue, 11 Restless, 16 Ripple, 6 Rising Sun, 9 Sappho, 15 Sea Bird, 8 Sea Foam, 8 Sea Flower, 14 Sea Gull, 9 Senator, 13 Spray, 19 Star, 19 Starlight, 12 Success, 14 Sunbeam, 6 Sunny Side, 6 Sunny South, 5 Sunrise, 13 Surprise, 17 Swan, 10 Sylph, 10 Telegraph, 14 Three Brothers, 17 Three Sisters, 7 Tidal Wave, 10 Trader, 13 Transit, 9 Traveler, 5 Triumph, 16 Twilight, 30 Two Brothers, 8 Two Sons, 10 Undine, 30 Union, 7 United States, 7 Vandalia, 12 Venus, 13 Victor, 14 Victoria, 9 Victory, 6 Village Belle, 15 Wanderer, 21 Wave, and 11 Zephyr.

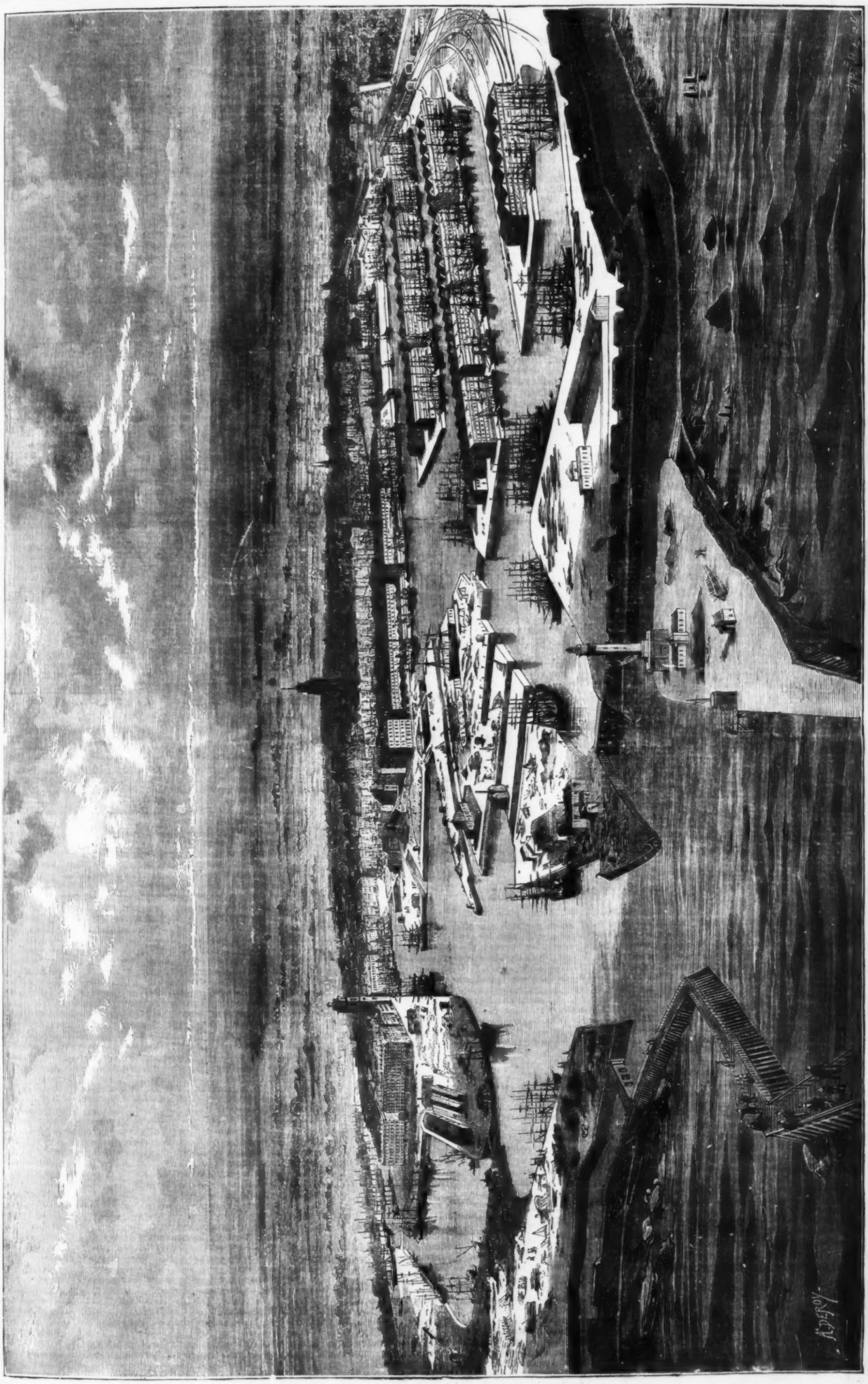
Among the quaint and more or less amusing names of vessels in the merchant list are the following:

The Am I, the Backache, the Bill the Butcher, the Big Sunflower, the Bull Frog, the Buttercup, the Chance Shot, the Come and See Me, the Hickory Bud, the Hope On, the I Don't Know, the If, the Lame Duck, the Let Me Alone, the Let Me Go, the Let Me Pass, the Little Bob B., the Live Yankee, the Night Hawk, the Nil Desperandum, the Nunquam Dormio, the O. K., the Only Daughter, the Only Sister, the Only Son, the Our Fritz, the Poor Jim, the Rough and Tumble, the Sea Angel, the Shoo Fly, the Sovereign of the Seas, the Tadpole, the Tally-ho, the Tarry Not, the Teazer, the Tourist, the Trackless, the Try Again, the Velocipede, the Veto, the Vim, the Vixen, the Wasp, the We're Here, the Whisper, the Why Not, the Wild Duck, the Wild Eagle, the Wild Gazelle, the X-10-u-8, the YI, the Coal Oil John, the Cock of the Walk, the Hard Times, the I Tell Ye, the Sleepy Joe, the Twenty-one Friends, the Don't Bother Me, the Fearless and Free.—*Journal of Commerce.*

THE PORT OF DUNKIRK, FRANCE.

AT the extremity of the Department of the North, France, on the Strait of Dover, is situated Dunkirk, the nearest port to London, and the safest refuge for vessels when they cross the Pas-de-Calais. It is a flourishing town, with an active commerce and manufactories of soap, beet-root sugar, leather, and starch, besides iron works and shipyards. In all ages, the inhabitants have been noted as mariners, privateersmen, and fishermen. The fisheries are important, especially those of cod, herring, and whale, and employ upwards of one hundred vessels. In all periods of history the port of Dunkirk has attracted the attention and excited the jealousy of foreigners; and in the numerous contests of France in former days with Spain, England, and the Netherlands, it has more than once paid by its ruin the ransom of the whole country. Thus it happened, for instance, in 1713, after the peace of Utrecht, when Louis XIV. dismantled its fortification, and filled up its port. From the beginning of the present century, and more especially since 1826, when it was made a free port, the progress of the town's commerce has been very rapid. The inhabitants, nearly all of the Flemish race, being endowed with much patience, energy and perseverance, and having a strong love for their native town, have gradually restored to their port all the activity and importance that it possessed in former times. And all this has been done without any intervention on the part of the government. Several years since, however, Dunkirk asked to be included in the programme laid out for improvements in public works, and, after examination of its needs, fifty million francs were appropriated for the purpose of enlarging the roadstead and docks. Formerly the docks had an extent of only about 5,600 feet, but now they are to be increased to 26,000 feet; and the old basins, which had a superficial area of 12,000 square yards, are to be doubled in size. It has become necessary to put Dunkirk on a footing to cope with Anvers, since it is the nearest port in France to Belgium and Germany, and is the best outlet for the products of the departments of the North and East—the richest parts of France.

One of the new docks—Dock No. 1—shown in the opposite engraving, was inaugurated on the 31st of October. It will give but small relief to the crowded port, but fortunately the remaining ones are to be pushed to completion as rapidly as possible. While this work is in progress it will be necessary, too, to excavate a large canal in order to put the town in a position to receive, at as little expense as possible, from the mines of Valenciennes, coal for the use of its numerous factories and for export. Thus will reach its roadstead all that outbound freight which other ports so eagerly demand. When all these contemplated improvements shall have been effected, the town, which at present has but 35,000 inhabitants, will certainly see its population doubled within twenty years. Dunkirk is already in importance the fourth port of France, and, in extent of tonnage and value of products transported, comes immediately after Havre and Bordeaux, leaving far behind it Boulogne, Cette, Rouen, Saint Nazaire, and Nantes. It has the pretension of passing from the fourth to the second rank of French ports; to recognize no longer but one rival—Marseilles; and to be at the North what the latter is at the South—the great mart, the principal maritime place of France. Its topograph-



PANORAMA OF DUNKERQUE, FRANCE, SHOWING THE NEW BASINS.

ical position justifies the pretension, and if Dunkirk does not succeed in occupying the second rank, it will at least take one equal to that of Havre. The imports and exports of Dunkirk have doubled during the ten years from 1870 to 1880, reaching the total of 1,500,000 tons. One of the chief articles of import is wheat from America.

IMPROVED PULVERIZER.

A VERY simple and effective pulverizing machine has lately been perfected by Messrs. Thomas B. Jordan & Son, London, and which is represented in the above engravings. Requiring a machine of this class for their own use, and not finding one in the market sufficiently simple or effective for their purpose, Messrs. Jordan, after long and careful experiments, perfected this machine, which constitutes an important advance in crushing apparatus. In our engravings, Fig. 1 is a general perspective view of the machine; while Fig. 2 is a vertical section, showing its internal arrangement. In this machine, two circular dished castings, A A, each having a long bearing, B, projecting from its center, are bolted together by their flanges, C C, and form the crushing chamber, D D, which has an inlet opening on the top, E, and two outlet openings, one on each side, F F. The two bearings carry short wrought-iron spindles at B, which meet end to end at the center of the crushing chamber. On the inner side of each spindle is keyed a set of four arms, H H H H, of the diameter of the chamber, the surfaces of the one set of arms being so angled at 45 degrees with the horizontal center line that they are parallel to and face those of the other set. These arms revolve in opposite directions, passing close to each other and to the sides of the chamber, and their backs are so formed as to create a blowing or fan action in the chamber, drawing air through openings placed in the sides and near the center of the chamber. On the outer end of the spindles, at B, are keyed pulleys for driving by belts, the spindles and their arms and pulleys being quite free and independent of each other to turn in reverse directions. One of the spindles, at K, has a worm engaging a wheel, and working the vertical shaft, L, which drives at a given speed the automatic feeder, M. By means of driving belts on the pulleys the spindles and their arms are revolved in

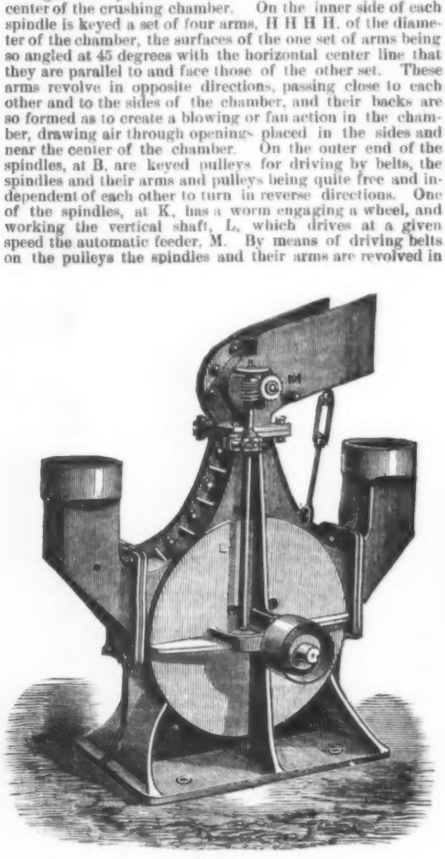


FIG. 1.

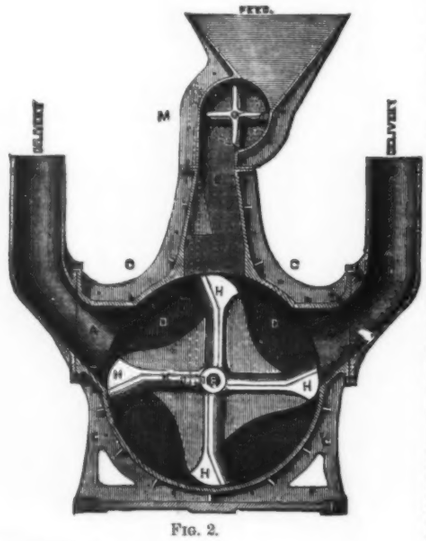


FIG. 2.

IMPROVED PULVERIZER.

reverse directions at any suitable speed for the material to be crushed. The material falling into the chamber from the automatic feeder is struck by one of the arms (owing to the angle of its face) into the path of those revolving in the reverse direction, and is by them, for the same reason, immediately returned; thus it is with great force struck to and fro from arm to arm until reduced as fine as required. There is therefore no grinding action the crushing being done entirely by percussion or impact, but without centrifugal force. This is the whole process of crushing. The fineness of the material leaving the machine is regulated not by sieves in the ordinary way, but by the current of air which immediately carries off all particles light enough for its force to suspend, and the force of this current can be accurately adjusted by closing or opening the apertures in the casing. The current in the machine is sufficient to carry the crushed material up 10 or 20 feet of pipe to another chamber, the height of which column of pipes also regulating the size of the particles delivered, different sizes being delivered at various levels if required. It will thus be seen that the machine is extremely simple; complete in itself and self-contained; there is very slight wear and tear; and great saving of power, there being no grinding action or friction between the parts of the machine, and the crushed material leaving the machine immediately in the state required, giving place to fresh crude stuff. Although very recently introduced, several of these machines are already in use in a cement factory, where they are doing good work. Being applicable to the reduction of any kind of material, to the finest possible powder without sieving, this pulverizer undoubtedly has a large future before it.—*Iron*.

GUN-COTTON EXPERIMENTS.

THE Royal Engineers have just experimented with gun-cotton upon two old chimneys at the Dockyard Extension Works, Chatham. The first was demolished by placing a necklace of gun-cotton inside the chimney, the total charge consisting of about 4½ lb., while the second was demolished by placing six charges of gun-cotton in the center of the base of the chimney, the total charge consisting of 28 oz. The experiments were a perfect success; the instant the electric spark ignited the gun-cotton, the chimneys became wrecks

GEORGE JAMES SNELUS.

THERE are four great inventions or discoveries that have given a great impetus to the manufacture of iron and steel during the present century, namely, the introduction of hot blast into the blast furnace for the production of crude iron; the application of the cold blast in the Bessemer converter for the conversion of liquid crude iron into steel; the production of steel direct from the ore on the open hearth; and the discovery of a basic lining, by which phosphorus is eliminated and all qualities of iron converted into steel. It is remarkable that only one of the inventors of these discoveries was directly or professionally connected with the iron trade. The discovery, says Dr. Ure, of the superior power of a hot over a cold blast in fusing refractory lumps of cast iron was accidentally made by my pupil, Mr. James Beaumont Neilson, engineer to the Glasgow gas works, about the year 1827, at a smith's forge in that city, and it was made the subject of a patent in the month of September of the following year. Sir Henry Bessemer, who thirty years afterward invented his converter for the production of steel by the application of cold blast, was also an engineer, who three years previously had no knowledge of the iron trade. Dr. Siemens, who both designed and put in operation the direct process of producing steel from raw ores, was a scientist and an inventor likewise unconnected with the iron trade; and Mr. Thomas, whose name has been most prominently associated with the basic process of dephosphorization, was a member of the Civil Service previous to his labors in perfecting that process. To Mr. Snelus belongs the honor of having been the first to discover the principle of the basic process, but being professionally connected with the trade, that was not his first and probably will not be his last discovery in the metallurgy of iron and steel. There is no one in the trade that has had a more rapid or more distinguished career; and perhaps no one has been more scientific in his data or more accurate in his conclusions. He is now a recognized authority on both practical and scientific questions in connection with the iron trade.

George James Snelus was born at Camden Town, London, on June 24, 1837. His father, Mr. James Snelus, a builder, died before young George had reached his twelfth year. The son was well educated, and trained as a teacher; but he had a predilection for applied science, which an accidental circumstance turned into the study of chemistry and metallurgy. Shortly after the invention of the Bessemer process, he happened to attend a lecture on it at the Polytechnic by Professor Pepper, and was so fascinated with the subject that he determined to devote himself to applied science. After some preliminary instruction, he became a student under Professor Roscoe, at Owens College, Manchester. He thus qualified himself as a teacher of science under the Department of Science and Art; and in order to complete his scientific training, he next became a student at the Royal School of Mines. Accordingly he studied there from 1864 to 1867, and his career was one of pre-eminent distinction. In the science examination of May, 1864, he gained the Royal Albert scholarship; he also took the first place and the gold medal for physical geography; the first place and the silver medal for applied mechanics; the second place and the bronze medal for inorganic chemistry; the third place and the bronze medal for magnetism and electricity; and lastly, the De la Beche medal for mining. During the second year of his studies at the School of Mines, he became the assistant of Professor Frankland at the Royal College of Chemistry, and successfully conducted science classes at the Royal Polytechnic and other institutions. At the end of his curriculum at the School of Mines, he became an Associate in Mining and Metallurgy. He was then (1867) appointed chemist at the Dowlais Iron and Steel Works, which were at that time the largest in the United Kingdom.

Mr. Snelus was one of the first members of the Iron and Steel Institute, and from its formation has been a frequent contributor and speaker at its meetings. His first paper was read at the Merthyr Tydvil meeting in 1870, "On the Condition of Carbon and Silicon in Iron and Steel." Its fresh information and elegant composition at once attracted attention; it combated some of the views on the subject propounded by Dr. Percy and other metallurgists; and its conclusions were adopted by Mr. I. L. Bell. At that time the question that was exercising the iron trade was the utility of the Danks puddling furnace; and so much interested were the members of the Iron and Steel Institute in the question that in 1851 they resolved to send a deputation to America to investigate the subject. Mr. Snelus was selected for that purpose as the best authority for solving the scientific questions involved in the process. His colleagues were Messrs. Jones and Lester. The commission sailed from Liverpool early in October, and visited the Cincinnati Iron Works, where the Danks puddling machine was at work, and where they conducted an elaborate series of experiments for the purpose of testing its capabilities. Along with the commission were sent forty tons of pig iron selected from Dowlais, Coneygree, Butterley, and Cleveland, together with a variety of felting materials, all of which were used in the Danks rotatory furnace. The general opinion in America at that time was that the machine was a success, and high hopes were entertained that at last a mechanical means of refining pig iron would supersede manual labor. The commission drew up their report at Washington, on December 12, and submitted it for the consideration of the committee of the Iron and Steel Institute on January 12. In addition to his labors in the production of this joint report, Mr. Snelus drew up a special one on the scientific features of the process. The analysis contained in that report were the most elaborate that had been made of the puddling process up to that time; and they were of permanent value as revealing the important fact, hitherto unsuspected, that phosphorus was eliminated very early in the puddling process and while the metal was in a fluid condition. Till then Dr. Percy had taught that phosphorus was removed by a process of liquation from the puddled ball; but Mr. Snelus now exploded this theory; and this discovery was the germ of the principle that is now likely to revolutionize the trade. Mr. Snelus made another important discovery about this time. He discovered at Dowlais the relation of the appearance of certain lines in the Bessemer spectrum to the length of the blow.

The Danks puddling process was not the only one he then investigated. Ten years ago there was a kind of mania for puddling processes, and one after another came up for examination. Mr. Snelus did valuable service to the iron trade by the thoroughness and impartiality with which he investigated their scientific features. In this way he examined the Sherman and Heaton processes, both of which attracted attention in their day, and presented the results in reports to the Iron and Steel Institute. In addition to his own reports on these processes, he took a leading part in several of the discussions on other inventions which had the same object in view, but all of which have since been superseded. He also contributed papers on the "Composition of the Gases Evolved from the Bessemer Converter during the Blow;" on the "Manufacture and Use of Spiegeleisen;" and on "Fireclays and other Refractory Materials." The subject matter alone of these papers indicates the extensive range of Mr. Snelus' researches, and all of them were, moreover, distinguished by their original information and lucid arrangement.

At the annual meeting of the Iron and Steel Institute held in London, in May, 1872, under the presidency of Sir Henry Bessemer, a lengthy discussion took place on the reports presented on the Danks and other puddling processes. In the course of it Mr. Snelus said: No one could be more satisfied than himself of the injurious effects of phosphorus upon steel, and of the facts that it did not go out in the Bessemer process. He had his own opinion about the reasons why it did not go out in the Bessemer process, which, however, he was not then at liberty to make known, because he was working in that direction, and had some hopes of surmounting the difficulty. He had not then gone far enough with his experiments. The experiments of which he thus clearly indicated the object were not made known publicly till seven years afterward, and then they created quite a sensation, for it was made perfectly evident that all that time Mr. Snelus was acquainted with the principle and properties of the basic lining as a means of dephosphorizing iron in the Bessemer converter. There are many well-attested instances on record in which different individuals have made the same discoveries simultaneously in different localities; and the present age adds many such instances to the record of the past. When the history of the inventions of the nineteenth century is properly written, it will be found that the conception of some of the most original and useful of them was allowed to lie dormant till the course of events forced their practical application, or till the announcement of some competitor in the same field of inquiry brought forward the original inventor to indicate his claims. The basic process of dephosphorization belongs to this category.

Mr. Snelus was first led to doubt the correctness of Dr. Percy's hypothesis, already referred to, that "phosphorus is eliminated by a process of liquation of fluid phosphide of iron from the pasty puddled ball," during his studies of the puddling and refining processes at Dowlais; and in examining the reactions that occurred in the Danks process he was struck by the fact that a good deal of the phosphorus was eliminated while the iron was in a fluid state. Impressed with the importance of this discovery, for such it was, he determined to investigate the matter still further. A comparison of the slags in the process of Welsh refining and Bessemer converting, showed him that that from the puddling process, in which the phosphorus was comparatively easily removed, was highly basic; while that from the refinery, in which only small amounts of phosphorus were removed, was less basic; and that from the converter, in which none at all was removed, was highly silicious. Other observations pointed to the same results, and led Mr. Snelus to the conclusion that phosphorus was removed in all processes just in proportion to the basic nature of the slag. With these data before him, he was meditating, in the beginning of 1872, how he could systematically obtain a highly basic slag in the Bessemer process; and he tried two or three materials of this nature, but found that they were not sufficiently refractory to withstand the intense heat of the converter. While his experiments were in this tentative state, he happened to make the fortunate observation that lime, when subjected to an excessively high temperature—in the Siemens steel melting furnace—became indurated and insensible to moisture. This fact, accidentally observed while performing an experiment for another purpose, suggested to him that lime in some form or other was the basic material he required for lining the converter; and being well aware that it does not do to burn lime at too high a temperature if it is to be caustic, he selected a particularly specified magnesian limestone. Shortly afterward he found that bricks could be made of lime or limestone, if the lime, when used for that purpose, were crushed quickly, compressed, and fired before it had time to absorb moisture. To consolidate these bricks, however, required an intense temperature, the more so when the lime was pure; but he found that it was facilitated by the application of a small quantity of oxide of iron or other fusible base. In order to put these conclusions to a practical test, he lined a small converter with crushed limestone, and fired it at a very high temperature.

His first experiment was made with one or two hundred-

weight of Cleveland pig, which was melted in a cupola, and then poured into this converter and blown in the usual way till the carbon lines disappeared after the fifteenth blow. The metal was then found to be free from phosphorus, which was traced into the slag. Several other blows were made, and samples of metal and slag taken at intervals during the blow. On analyses being taken the results showed clearly that so long as the slag was kept basic there was no difficulty in removing the phosphorus. To make sure that this was the secret of success, he had the same small converter lined with gannister, and then he found that the phosphorus, as hitherto, remained in the metal. Next, he tried to line a 7-ton converter with the same material that was used in the small one; but he found considerable difficulty in preparing a lining sufficiently strong of that size. This led him to defer further experiments till a more convenient season; but in the meantime he secured his discovery by patent. In his patent he specified the use of lime and limestone, magnesian or otherwise, in all the forms he thought it possible to use it, for "the lining of all furnaces in which metals or oxides are melted or operated upon with fluid." "I felt," he says, "that, although I had found the solution of the problem so long and anxiously looked for, my plans required to be tried on a larger scale before they were fully laid before the public, not because there could be any question that the same chemical action that succeeded with one or two hundredweight of metal was likely to be reversed when operating upon tons, but because I felt that there were many points of detail that would require to be worked out. These details have been filled up by subsequent workers, but it is gratifying to me that the complete success now attained follows closely some of the lines laid down. To the question why I did not follow up my discovery and put my plans into practice, my answer is that I had just taken the management of a concern the interests of which were opposed to the solution of this problem, and therefore having secured the ground by patent, I was compelled to wait a more favorable opportunity for putting my plans into practice. There was also a good deal of skepticism among those interested as to the possibility of solving the problem, and none seemed to care to take it up."

The correctness of this account is verified by some remarkable facts. Mr. Snelus had confidentially told some of his friends of the experimental success of his invention in the long interval between its conception and perfection.

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Among them was an eminent engineer, who, on hearing that a patent had been taken out for this process, strongly advised Mr. Snelus not to dabble in patents, as they did not pay; but to show that his mind was open to conviction, this friend added: "When you can show 1,000 tons of rails made by the process, then I will believe in it." In May last this same friend stated that he had recently had occasion to test 1,000 tons of rails made by the basic process as compared with 1,000 tons made by the old process, and that he found no difference whatever. Again, a few minutes before Mr. Thomas vaguely announced his discovery of the same process and his more perfect application of it, Mr. Snelus gave a short account of its leading features to the Iron and Steel Institute. Before any one else mentioned the elimination of phosphorus by the use of magnesian limestone, Mr. Snelus stated that he had succeeded in that way; and that, though there was a difficulty in constructing a practical apparatus in which the limestone could be used, he had such confidence in the ultimate success of that material for this purpose, that he still intended to maintain his patent, although it was six years old, and the seven years' fee would soon have to be paid.

As to the ultimate effect of the process Mr. Snelus believes that it is not only capable of producing from the poorest ores a metal having all the properties of Bessemer steel, but also of making the finest classes of steel for cutlery purposes. After careful investigation he has come to the conclusion that the essential for a steel to carry a keen cutting edge without being brittle is that it shall not only be free from silicon and have the right proportion of carbon, but that it shall be absolutely free from phosphorus. He believes that the basic process is capable of affording metal, even from inferior pig, eminently suitable for the manufacture of cutlery and other goods at one-fourth the price of the high-class steel which has hitherto been used for that purpose.

The rival inventors and patentees had the sense to avoid litigation as a means of settling their claims. Messrs. Thomas and Gilchrist, who made the process a practical success, agreed with Mr. Snelus to submit their claims as to the way in which the profits should be divided to the decision of Sir William Thomson; and by this amicable arrangement no legal difficulty was allowed to retard the immediate application of the process. The patent rights of Mr. Snelus extend to America and the United Kingdom; but not to the Continent. The history of his American patent is another evidence of his priority of invention as well as his dilatoriness in availing himself of it. When he discovered, in 1872 that in principle he had solved the problem, he shortly afterward fully detailed it to his friend Mr. E. Cooper, of Cooper & Hewitt, of New York, and that gentleman urged him at once to take out an American patent; but here again Mr. Snelus' habitual desire to thoroughly perfect all its details nearly lost him his rights. In the hope that he would soon find an opportunity of perfecting the working of the process, he disregarded his friend's advice until Mr. Thomas announced his discovery of it in 1878. Mr. Snelus then joined Messrs. Cooper & Hewitt in taking out an American patent, which secured the original inventor a share in the royalties from America, where the process is now being applied.

The work which so absorbed Mr. Snelus' attention as to put the basic process in abeyance was the remodeling of the West Cumberland Steel Works. His appointment as manager of the Bessemer department of these works occured shortly after he had taken out his patent in England, and a few months afterward he was promoted to the position of general manager of the entire works. His scientific and practical knowledge of the Bessemer process enabled him to introduce some valuable improvements. Of his scientific attainments we have already given account; his practical knowledge was also extensive. During his visit to America he visited most of the large works there, and took notes of everything he saw in connection with the manufacture of iron and steel. He made careful observations of the improvements made there in the mechanical details of the Bessemer process; and was so impressed with the advantages of the Holley patent for Bessemer vessel bottoms, that he made a special journey for the purpose from New York to Harrisburg, in order to satisfy himself at the latter place that he perfectly understood the details of this invention. He afterwards introduced the Holley patent at the West Cumberland Works, where it has been in use ever since. The year after his return from America, he visited Germany, and he made a sojourn at Hoerde purposely to see the process of ascensional casting under Mr. Pink. He was so convinced of its utility that he wished to introduce this improvement also at West Cumberland, but found that the size and construction of the Bessemer pits there were not suitable for it. His next improvement at West Cumberland was of a more original and interesting character. At that time the introduction of the fluid metal direct from the blast furnace to the Bessemer converter was occupying the minds of the trade. Hitherto the general practice was to remelt the pigs for the converter, and it was contended by many that to convert the fluid metal from the blast furnace into steel, without cooling and remelting, would be impracticable in working and uncertain in results. Mr. Snelus was among the first in England to advocate the direct conversion of the fluid iron into steel. This method is now in general use; and Mr. Snelus' own appliances for carrying it out are of a model kind. The West Cumberland Iron and Steel Works consist of six blast furnaces, 70 feet high, each capable of making over 500 tons of hematite pig per week. The distance between the blast furnaces and the converters is 350 yards. To carry the molton metal this distance he designed a large ladle capable of holding 8 tons. It is so placed in the center of a carriage that the greatest stability is obtained without the need of any balance weight, and it is turned over by a simple cast steel worm and wheel. The weight of the whole apparatus is under 10 tons. In practice about 3 tons 10 cwt. of molton iron is tapped from each of two furnaces into the ladle in order to insure a uniform charge. The tapping of both furnaces is often done in about five minutes, and in less than that time the charge is weighed, taken to the converters, and poured into the vessel. One ladle lasts from 100 to 200 casts before the "skull" needs to be taken out. By this method and appliances considerable benefit arises from the increased yield of metal; and Mr. Snelus stated, in 1876, that he estimated the saving in labor and fuel at 4s. or 5s. per ton. Rails and plates are made at these works by some of the latest and most mechanical improvements. Forty-eight steam boilers and 52 engines are employed to supply motive power. The hematite ore that supplies the works is brought from the Cleator Moor Mines; the coal and coke from the Company's collieries, about three miles from the works; and the limestone flux from quarries about eight miles distant. There are not many works in England that have the raw materials in such close proximity.

Among Mr. Snelus' miscellaneous contributions to metallurgy, it may be mentioned that he is the author of the articles on Iron and Steel in the latest edition of Muspratt's "Chemistry of Arts and Manufactures." The editor of that standard work asked Mr. I. L. Bell to tell him who was the most competent man in England to write such articles, and Mr. Bell recommended Mr. Snelus. The articles were written in 1877–8. At the Paris Exhibition of 1878 Mr. Snelus was an exhibitor on his own account of a very elaborate collection of analyzed samples illustrating the manufacture of iron and steel in England. For this the jury awarded him a gold medal as a "collaborateur." The collection was purchased by Professor Deure for the Polytechnic School at Aix-la-Chapelle.

Nor is metallurgy the only field in which Mr. Snelus has earned honorable distinction. As one of the rifle volunteers, whom he joined in 1860, and among whom he has for many years been a commissioned officer, he has occupied a foremost place as a successful "shot." In 1864 he won a place in the first 60 for the Queen's Prize at Wimbledon; in 1868 he won the first prize for small-bore rifles in the Albert competition; and he has frequently won other prizes. For 12 years—1866–77—he was one of the competitors in the volunteer match between England, Ireland, and Scotland, and his name often stood among the highest scores.

In the prime of life, in perfect health, and of moderate habits, Mr. Snelus' past career gives promise of future usefulness. In the 12 years that have elapsed since he completed his scientific training no man has done more useful or original work in promoting the metallurgy of iron and steel. His industry is as great as his ability; and the soundness of his views is only surpassed by the readiness and liberality with which he communicates them to others for the benefit of the iron trade.—*Universal Engineer.*

A SAILOR was recently killed in England by placing his hands on an electric lamp, so as to connect himself with the current. His death was instantaneous, and his burial had to take place at once, as the tissues of his whole frame were rent and blackened. A person wearing a watch must not approach too near the lamps when in operation, as the watch spring will be so magnetized that it will have to be replaced.

COACH PAINTING.

THE following essay, which we find in *The Hub*, was offered in competition in Class No. 15 of the Carriage Builders' National Association's Prize Offers for 1880, but was not acted upon in time for report at the late Convention.

INTRODUCTORY.

The first object in coach painting should be to impart to the surface of the vehicle durable protection against exposure. After such a foundation has been secured, the painter's next aim should be beauty of finish. A durable foundation is one that has the power to resist the influences of ordinary use and exposure. The foundation means all the painting up to the color. The finish means the colors and the varnish. A good foundation is that which will remain uninjured after the varnish and color have gone, even if removed by ammonia, and one which can be refinished several times. The foundation of paint should last as long as the vehicle.

MAKING THE FOUNDATION FOR THE BODY.

Such a foundation may be prepared as follows: First, coat the woodwork of the body with a preparation of raw oil, seven parts, and gold size, one part; and see that all is absorbed that is put on. If any glossy spots remain, rub them off with a rag. When dry, the finger nail will make a white mark on it; that is, it will wear the finger nail. Then give a coat of lead color of eggshell gloss, made as follows: Take of the best keg-lead as much as will make a quart of paint, add two ounces of raw oil and the same of gold size, tint with lamp black, and thin with turpentine, and then mix thoroughly. When this coat will wear the finger nail, give a second, third, and then a fourth coat, each time testing the hardness with the finger nail.

Now make putty or stopping thus: Mix dry white lead with equal parts of elastic varnish and gold size into putty; add one-fourth of its bulk of keg lead, tint with lamp black, and knead thoroughly.

After the body has been puttied two or three days, proceed to fill as follows: Take French umber or Reno's filling and white lead, equal parts; grind stiff in turpentine; add to this two parts of elastic varnish and one part of gold size. Give three coats of this, and then add a little lamp black for a guide coat, and give a fourth coat. See that each coat is thoroughly hard; then it is fit to grind down. When ground down, give a coat of flat lead color with a camel's hair brush, and when this is dry examine thoroughly and scumble or glaze any defective places; and when they are hard smooth them off with a small piece of pumice stone, and prepare the whole surface with No. ½ sandpaper; the foundation is then complete.

MIXING AND APPLYING THE COLORS.

As all colors are now ground in fine driers suitable to the pigments, such colors should always have a small quantity of raw oil added to bind and make them elastic. Three coats of color should always be given. Some painters prefer two, and one of color-and-varnish; but this always changes the tint by floating the lightest substance in the color to the surface, and then rubbing mars it. Worse than this, floated or false tints, being exceedingly thin, are consequently transient, and deepen or fade, sometimes in blotches. Colors, to be permanent, should have depth of body. Single glazing, and floated colors, always fade or deepen rapidly.

FLOATED OR FALSE TINTS.

In color-and-varnish, drop-black floats up an olive-green scum, which becomes greener with each coat of varnish. All blues are ruined in it. Vermilion should always be used flat, as the float in color-and-varnish blackens rapidly. Greens change two or three shades deeper, and turn muddy. Yellows spot, and soon look tawny. Purple and violet are best in flat colors. When a white surface is wanted, each coat should be mixed with a little pale elastic varnish, to draw down the brush marks. The best way to get a snow-white surface is to put four or five coats of flat white lead over the foundation, and each coat should have a little pale, quick rubbing varnish in it; when these coats are hard, grind smooth with lump pumice, and then give one light coat of pale rubbing varnish, and finish with one coat of pale wearing body for reliable work. For the above reasons do not use color-and-varnish.

When three coats of color have been laid satisfactorily and have become hard, give one coat of elastic rubbing varnish, and when this is hard, rub off uniformly, but not too much. Then add another coat of the same varnish the same day you rub, so that the body of rubbing varnish will be more homogeneous. When hard, rub thoroughly, but do not cut through the last coat, for if it is cut through another coat of the same rubbing varnish will be needed.

After your surface is satisfactory, let it stand one day to reharden, and finish with the best flowing elastic wearing-body varnish. Be sure that the finishing coat has all these qualities, because they are requisite to insure the desired effect and durability.

PAINTING THE RUNNING PARTS.

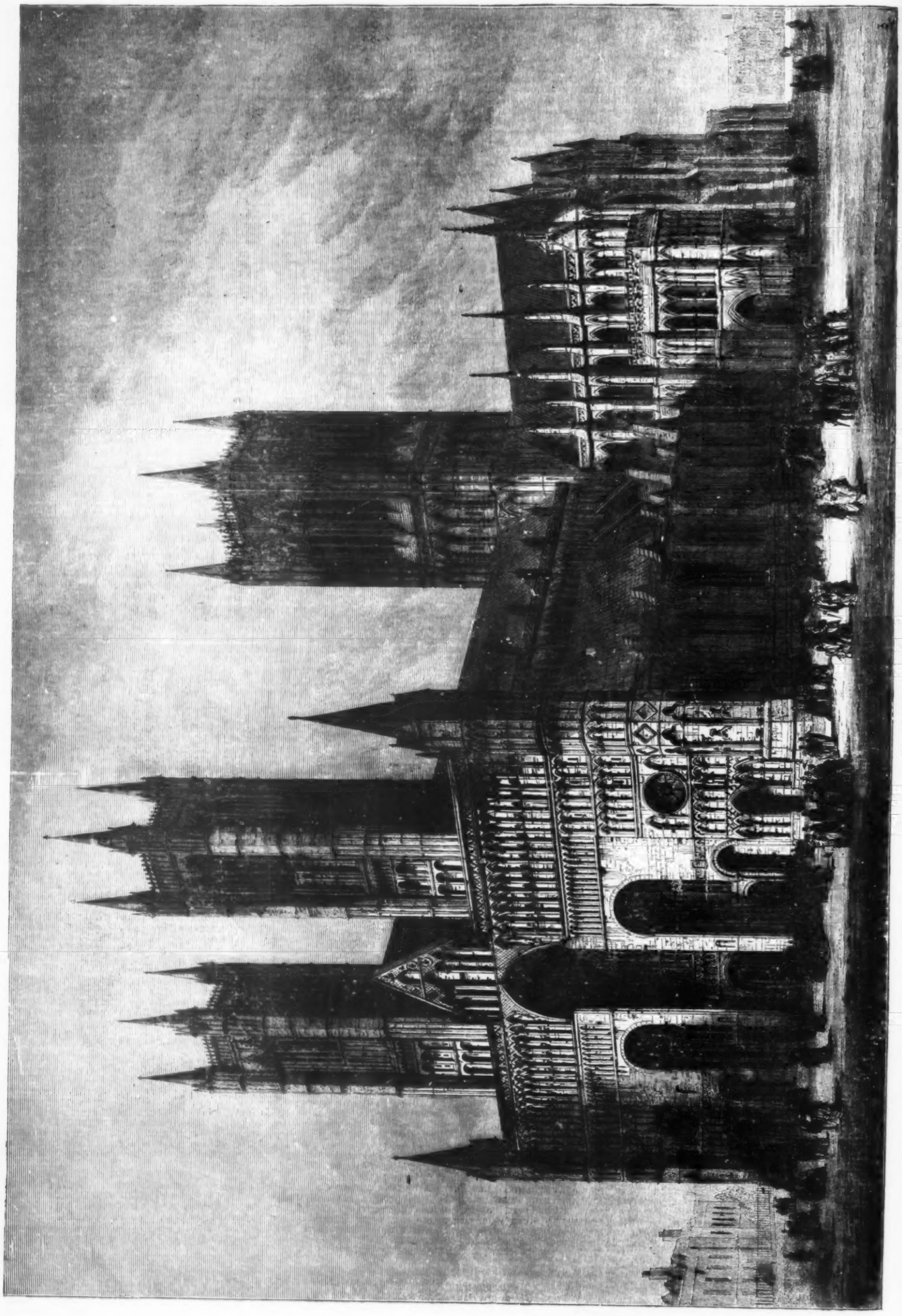
The running parts should be sandpapered, filed, and made smooth on the first coat of priming, and then one coat of eggshell gloss lead color should be given. When hard, stop, and scumble or glaze. Use No. 1½ sandpaper to reduce, and when satisfactory give another coat of the same lead color. Then re-examine, and touch up defective places with putty. Use the same kind of putty as on the body, which never shrinks or falls out. When a third coat of eggshell gloss lead color is dry and rubbed off with curled hair, the foundation for the running part is complete.

Now give three coats of color, and be sure that raw oil is used in the color for the running parts. When the color is hard, give one good coat of elastic rubbing varnish, and when carefully rubbed it is ready for striping. When striped, finish with two coats of elastic varnish.

We have now painted a coach. We will proceed to remove it or take it apart, in the usual wear and tear method.

The two principal enemies to paint are the one which oxidizes, hardens, and ultimately makes rigid and brittle all varnished surfaces; and the other softens and reduces by a corrosive process. Although these two agents of decay seem to antagonize each other in their methods, yet their work supplements each other in reducing the beautiful surfaces the coach painter takes so much pains with.

Oxygen, the first of these, is the hardening or drying



LINCOLN CATHEDRAL.

principle in paint and varnish. The term "drying" supposes evaporation; but, excepting turpentine, other diluents used in paint and varnish absorb from the sunlit air, and actually increase in weight as they harden. Hardeners are of two kinds, those which supply oxygen in the shape of active oxides, and those which render the paint, oil, or varnish more susceptible to the oxygen which they absorb from the air. Paint or varnish hardens best in ordinary sunlight. The direct rays of the sun form one of the best hardeners. An elastic body of paint and varnish will wear longer than one which is got up hard and full of oxides, because it takes longer to become brittle and to crack. When a varnished surface has become so rigid, it breaks and cracks by the shrinking and swelling of the wood and iron it covers, from cold and heat of the weather, it has arrived at the first stage of ruin. Revarnishing is then too late, because those cracks will enlarge and continue to show in the recent varnishing.

The other known enemy is the volatile alkali ammonia. It is always present in low places, where there is no ventilation, rising from drains, stables, cesspools, etc. This alkaline vapor attacks the fine film which is the gloss of the varnish, and, uniting with the oil of the varnish, leaves the gum a brittle, sandy powder, to fall gradually away as the corrosion goes on, until it arrives at the lead or foundation, where it stops. It is here also where the cracking from oxidation of the varnish stops. If the foundation has been well got up, as we have described, and been revarnished three or four times and cracked through all the varnish, the same foundation can be used again. *Aqua ammonia* applied with a brush to such old cracked varnish surfaces will soften it to the lead in a very short time. This ammonia does not seem to penetrate the lead foundation, and a flat knife or scraper will remove all the old varnish, and the same foundation may be used again to finish over. We have seen the original foundation of paint used twice on street cars during eight years, and it can be used again more than once if no catastrophe intervenes. No other foundation than a solid wall of white lead, painted firm and elastic as we have described it, will do this. A foundation of dead, flat lead, or without lead, will be destroyed by the oxidation of the varnish; and to repaint, the burning lamp must be used. A private carriage painted by the process we describe will last under ordinary use for eight to ten years without repainting, when the original foundation can be used again.

All irons on a carriage should be primed with red lead and lamp black, to arrest oxidation or rust. Red lead is a neutral mineral paint. It is white lead calcined by a distinct process. The calcining destroys the acid remaining in white lead, and makes it neutral to the rusting process of iron. All natural "mineral paints" are fatal to iron surfaces, because they contain active oxides of iron when moisture of water makes the third party.

Our theories of building up a durable wall of paint and varnish on a coach are about concluded. We now approach the decorative art—the harmony of colors.

HARMONY OF COLORS.

Color is recognized in three distinct primaries: red, yellow, and blue. Blue is usually named before yellow, because perhaps it is a dominant color, even more so than red, judging from the quantity always visible in daylight. Still in the ordinary processes by which colors exhibit themselves, red appears first, yellow next, then blue. The intermediates or secondaries, are these primaries mixing as they approximate each other in their natural order, as seen in the prismatic spectrum or rainbow. Red reaching into yellow forms orange, yellow into blue forms green, the outside margins of red and blue incline to purple, and red and blue, although they do not mix in the spectrum or rainbow, being apart, yet when these two colors in the spectrum are bent so as to lap each other their combination is purple. There are what are called tertiaries, a combination of three colors, thus: green and red make olive; blue and orange make citron; and purple and orange make maroon. Of course certain proportions in each case must be observed. Imagine three lines drawn to indicate the primaries, four lines to indicate the secondaries, and three lines to show the relative position of the tertiaries, and you will have an idea of the relation which these colors have to each other.

		Maroon.		Citron.		Olive.	
	Purple.		Orange.		Green.		Purple.
		Red.		Yellow.		Blue.	

It requires three colors in some of the various proportions to make a harmony; the three primaries do not form a harmony, they merely contrast. Three or more colors on a proper ground, arranged in their proper relations to each other, form a theme or harmony of coloring.

The tints and hues of colors are not arbitrary like musical tones. When you strike C upon the key-board of an instrument, you have intoned a note of a given number of vibrations, which is known as C under all circumstances, excepting in an enharmonic change, which does not alter the note or its relations. But in color, the tones and their relations are left to the skill of the colorist. Musical notes are limited to not much over 90, and audible notes do not exceed 100; but the range of the eye in detecting variety in tints of color is enormously beyond this.

The colorist, then, must consider his groundwork and arrange his theme upon the relations which tints and hues bear to primaries. You can not learn coloring any more than you can learn music. To be a colorist you must study, and the more you study colors and their relations to each other, the better you will be able to avoid shocking your neighbors by awful combinations of them. The richest coloring is not upon a field of a glaring primary; because, first, such a field or ground absorbs or smothers the effect, and the only thing that will redeem it is gilding; and second, you limit your choice of arrangement to the two remaining primaries. Let your groundwork be some rich-toned neutral, which will be in harmony with your key-tone or leading color.

OATMEAL PASHA.

LINCOLN CATHEDRAL.

Of the many celebrated historical ecclesiastical buildings of England the Cathedral of Lincoln is one of the finest. It stands on an eminence is 534 ft. long, 250 ft. wide; it has three towers, one of which is 53 ft. square and 300 ft. high; the others 180 ft. high. It was in one of these towers that the famous bell, Tom of Lincoln, hung until 1834, when it was broken up for recasting. The drawing presented opposite is by S. Reed, and the engraving is from the London *Illustrated News*.

PHYSICS WITHOUT APPARATUS.

CONTINUING our remarks on the subject of *density*, with which we closed our last article, we may show, by a very simple and pretty experiment, called the "vial of the four elements," that liquids of unequal density seek different levels in the same vessel. This consists of a flask containing three or more liquids which do not chemically or mechanically unite when poured into the same vessel—such as mercury, water, and turpentine. In a state of equilibrium these liquids will adjust themselves one above another, in the order of their respective specific gravities; the heaviest (mercury) falling to the bottom, and the lightest (oil) rising to the top. The experiment may be varied by coloring the water blue with a little aniline, and the turpentine red with a little alkanet root.

FIG. 1.—THE CARTESIAN DIVER.

The principles of flotation may also be very easily demonstrated. As well known, perhaps, to the reader, when a body is plunged into a liquid, it is urged downward by its weight, and upward by the buoyant effort of the liquid. Three cases may arise, depending on the relative intensity of these forces: (1), when the density of the body is *greater* than that of the liquid; (2), when the density of the body is less than that of the liquid; and (3), when the density of the body and liquid are *equal*. Now each of these different cases may be readily shown by the hydrostatic toy known as the "Cartesian diver," which may be easily constructed as follows from a bottle, a nut-shell, and a piece of sheet rubber. After opening the nut longitudinally, pick out the meat and put the shell together again, cementing the edges with sealing wax. To the wax fix two threads, by which is to be suspended either a small figure carved from wood, or a small porcelain doll. Take care to leave a small aperture about the diameter of a pin at the bottom of the nut-shell at O. Put the figure and the shell (which is to serve as a float) in a basin of water, and suspend from the base, as shown in Fig. 1, a shot of sufficient weight to cause the figure to stand upright and to sink the float so that the top is about even with the surface of the water. Having filled the bottle with water, introduce the apparatus, and tie tightly over the mouth the piece of sheet rubber. If now the rubber be pressed with the hand, the air is compressed, and the pres

FIG. 2.—INERTIA.

FIG. 3.—EXPERIMENT ON ELASTICITY.

FIG. 4.—CORK BALLS RAISED BY A JET OF WATER.

FIG. 5.—CAPILLARY SIPHON.

sure, transmitted through the different horizontal layers, condenses the air in the float, and causes the entrance of a portion of the liquid through O; the floating body becomes thereby heavier, and consequently the diver descends. When the pressure is removed from the rubber, the pressure becomes what it was before, and the diver ascends.

A number of experiments on the subject of *inertia* have already been noticed, but here is one which is very curious, and which may be successfully performed after a little practice. Lay one end of a slip of paper on a smooth marble mantel-piece or table (Fig. 2), and on it stand a silver dollar on its edge. Now, holding the free extremity of the paper with the left hand, give the paper a smart blow downward with the forefinger of the right hand. If the experiment be performed dexterously, the paper will slide from beneath the coin without disturbing it. On the same principle a tablecloth may by a quick and sudden jerk be removed from a table without disturbing the plates upon it. A very familiar illustration of inertia may be shown as follows. Place a smooth card over the open mouth of a wide-mouthed bottle, and on the card, directly over the mouth, lay a small coin. By snapping the card adroitly with the finger and thumb it may be struck out from under the coin, and the latter will fall into the bottle. The inertia of the coin prevents the sudden impulse given to the card from being immediately communicated, and it therefore remains in place

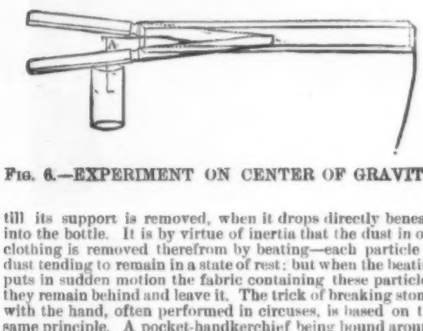


FIG. 6.—EXPERIMENT ON CENTER OF GRAVITY.

till its support is removed, when it drops directly beneath into the bottle. It is by virtue of inertia that the dust in our clothing is removed therefrom by beating—each particle of dust tending to remain in a state of rest; but when the beating puts in sudden motion the fabric containing these particles, they remain behind and leave it. The trick of breaking stones with the hand, often performed in circuses, is based on the same principle. A pocket-handkerchief being bound around the right hand, the stone to be broken is held with the left hand over another and larger stone, or over a piece of iron. Care is taken to hold the stone to be broken at a very small distance (imperceptible to spectators) above the other. Now when the fist is suddenly brought down on the stone the latter partakes of the same velocity, and, on contact with the lower stone, promptly breaks, much to the amazement of the lookers on.

Elasticity of solids may be shown very easily by placing five or six silver dollars in a row on a table so that their edges touch each other (Fig. 3), and then removing the piece to the right a short distance and suddenly shoving it up forcibly against the end piece of the row. The shock will be transmitted by the elasticity of the pieces, through the whole series up to the last piece in the row, which alone will be projected at some distance from its neighbors. If two pieces be projected against the row, the two pieces at the other end

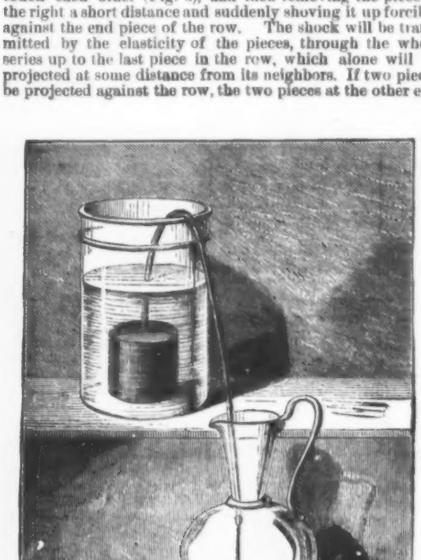


FIG. 7.—SIPHON CARBON FILTER.

will be thrown out of their position at the same instant. This effect, due to the *mass*, is very curious to observe. This is usually shown in courses of physics by a series of ivory balls suspended by strings

Fig. 4 shows the arrangement of a very attractive experiment in which small balls are made to rise and to be held suspended in the air by a jet of water. The apparatus is made by soldering an inverted tin funnel inside of a circular tin pan, through the two opposite sides of which are apertures for the introduction of a small iron or brass tube to furnish the jet, and a small pipe to lead away the surplus water. The water may be supplied from the faucet in a stationary wash-bowl through rubber tubing. The whole affair is covered by a glass shade, such as is used for protecting clocks or wax flowers, and which may be purchased quite cheaply. A few cork balls painted different colors are placed in the funnel, where, owing to the inclination of its sides, they always roll to the bottom precisely at the spot where the jet begins. Raised by the latter, they remain suspended for some time; and, when they chance to fall, they are at once elevated again and kept rolling about against the surface of the liquid. The balls are held up against gravity by the upward force of the jet, and at that point where the velocity of the stream equals the force of gravity. They are crowded against the stream by the unequal lateral pressure of the air, which, on the side of the jet, is less than on the opposite side, owing to the motion of the water driving the air away from this side, and so somewhat diminishing the pressure; this being proved by the fact that balls will not rise on the same stream in a vacuum.

Experiments on the subject of center of gravity might be multiplied indefinitely. We have given a few, but here is another: Into a pine-wood ruler insert the pointed ends of two knives of equal size and weight, and in the end of the ruler, between the knives, stick a large sewing needle. Thus constructed, the apparatus will be found to be in equilibrium when its needle is balanced on the point of another needle embedded vertically in a large cork (Fig. 6).

Capillary action may be very simply shown by dipping one edge of a lump of sugar in a liquid, when the whole lump will gradually become moist. By the action of the same phenomenon small pieces of iron, or small sewing needles, if greased, may be caused to float; the water being depressed all around them, more of the fluid is thus displaced than is equal to the weight of the metal, and consequently they float. The same phenomenon of physics may be elegantly shown with two wine glasses and a strip of cotton cloth. Place one of the wine glasses above the level of the other (Fig. 5), fill it with water, and, having moistened the strip of cotton, insert one end in the water and the other end in the empty glass. In about an hour, the lower glass will be found full of water, while the upper one is empty—the water having been "siphoned" off by capillary attraction through the cotton.

The *siphon*, properly so-called, may itself serve as the base of a practical experiment in filtration. A plastic porous carbon filter has been devised by a M. Bubring which, adapted to a tube bent into the shape of a siphon, serves for purifying turbid waters by filtration. Fig. 7 shows the appearance of this apparatus in operation. The siphon having been filled, and the water having begun to flow, it traverses the carbon and falls in a limpid stream into the receptacle beneath. Any one can construct such a filter for himself by fixing a large piece of charcoal to the lower end of a simple glass siphon.—*La Nature.*

MICROSCOPY.

AT the late meeting of the American Association, in the room occupied by the microscopists, three communications were read: "On the Limits of Visibility with the Microscope," by A. E. Dolbear; "Minute Anatomy of the Human Larynx," by Carl Seiler, and "Some of the Infusoria Found in Fresh Pond," Cambridge, by S. P. Sharples. Of these, Prof. Dolbear's work is of general interest. Some years ago it was thought that the limits of visibility with the microscope would be reached when the object to be magnified was about half a wave length of blue or violet light in dimensions, say the one-hundred-thousandth of an inch; but Nobert's lines are now said to be seen like pickets in a fence, and Beale pictures microscopic fungi smaller than that dimension. So it is worth while to consider the likelihood of our ever being able to see an atom or a molecule. According to Maxwell's measurements an atom of hydrogen has a diameter of about one two-millionth of a millimeter. A molecule may be made up of almost any number of atoms to a thousand or more. A molecule of alum has a hundred atoms, one of albumen nine hundred, and so on. If such groups of atoms are arranged in their dimensions, their relative diameters would be as the cube root of their number of atoms, and the alum would be four and six-tenths times the diameter of the hydrogen atom, and the albumen would be nearly ten times this. That would bring the diameter of the latter down to the two-hundred-thousandths of an inch. If a good microscope will show a point but one four-thousandth of a millimeter, its magnifying power would have to be increased but fifty times in order to show the molecule as a point, while a hundred times would probably reveal something of its structure, if dimension was the only condition required. But we know that what we call heat is the vibratory motion of these atoms and molecules, and, moreover, these variations take place at so rapid a rate as to strain our mathematical methods to express it, while the result among the atoms and molecules of this vibratory movement is to give them a greater or smaller latitude of movement—elbow room, which is called their free path. It varies, being greatest in gases and least in solids. In a gas like hydrogen, at the temperature of zero, this free path is about two hundred times the diameter of the atom, and in water, according to Mr. Hodges' calculations, is less than the diameter of the molecule. In a microscope motion is magnified as well as the object, and the swifter a thing moves the more difficult it is to see it. The movements of a molecule must prevent us from seeing it, even though our microscopes might otherwise reveal them. But there is still another reason why we may not see them. Molecules are transparent. The sunlight streams through our atmosphere, and does not heat it, and we cannot see it; if a molecule of oxygen were ten times larger than it is, and it could be grasped and held still in the field of the microscope, there is no reason to suppose that it could be seen, because it is perfectly transparent.

LAW ACCORDING TO WHICH THE METALS AND THEIR ORES CAME TO, OR NEAR TO, THE SURFACE OF THE EARTH.*

By PROF. RICHARD OWEN, M.D., LL.D.

WE might reasonably expect that the metals requiring temperatures from 2,000° to over 2,500° F. to melt them (such as iron and gold) would be the first to solidify, as our earth cooled, and therefore more likely to exist among older rocks than such metals as zinc, lead,† and tin, which melt at a comparatively low temperature, and consequently could not become solid until the earth's crust had cooled to 773°, 612°, and 442°, the melting points respectively of these metals. Such we find to be the fact. Furthermore, Faraday demonstrated that all substances, when suspended freely between the jaws of a powerful horseshoe magnet, would place themselves either *paramagnetically*, the same as iron and some other metals, or *diamagnetically*, the same as bismuth and numerous other bodies; and the magnetism developed for the time being in that horseshoe magnet may be, and often is, produced by powerful currents of electricity.

It has been proved that there are constantly currents of electricity passing in the earth's crust, chiefly in an opposite direction from the earth's revolution, perhaps, therefore, operating mainly in causing a freely suspended needle to place itself at right angles to the plane of those so-called currents.

It seems, therefore, further, not unreasonable to expect that metals, when about to solidify, if free to permeate cavities in all directions, should assume, relatively to these currents of electricity, respectively either a paramagnetic or a diamagnetic position. Such seems in reality to have been the case: Iron, manganese, platinum, nickel, cobalt (and probably other paramagnetic bodies, but time has not permitted this latter investigation) will be found chiefly occupying north and south belts, corresponding pretty generally with meridians, while gold, silver, copper, tin, lead, zinc, antimony, bismuth, and other diamagnetic bodies will be found in east and west belts, sometimes on regular parallels, of which the terrestrial north pole is the center; sometimes in east and west curves having one or other of the continental foci (pointed out in the law of land-forming, as their center. The apparent law, then, briefly formulated, may be thus expressed:

"The paramagnetic metals, in consolidating, arranged themselves along north and south belts, usually near the median line of each continent, and are found in older rocks as well as newer. Diamagnetic metals are most commonly to be found in belts, not necessarily continuous, but running more or less east and west, and except, perhaps, in the case of gold, silver, and copper, not so much in older rocks as in later formations."

Demonstration:

I.—PARAMAGNETIC METALS AND THEIR ORES.

1. *Iron.*—A considerable portion of this metal, as magnetite, both in the United States and in Scandinavia, is magnetic, possessing polarity. Specimens from Magnet Cove, Ark., and from near Pilot Knob, Missouri, in the United States, and from Dannemora, in Sweden, present this character very strongly.

(*a*) Nearly all the important iron of the United States (as can be ascertained from Dana's Mineralogy, or readily seen by inspecting Map No. VIII. in Cornell's Phys. Geogr.) occupies a north and south belt, between the meridians of 77° and 91° long. W. of Gr.), extending north and south from Lake Superior to Alabama, average lat., say 40°.* On the opposite side of the globe this belt, prolonged in a great circle, will include the main iron belt of Asia.

(*b*) The iron of Europe is in a belt about (20) twenty degrees, or nearly 800† statute miles in width—namely, from long. 5° W. to long. 15° E., extending north and south from Scandinavia to Tunis, thus being about 90° distant from the American Asiatic belt.

(*c*) The only other iron laid down in Cornell is in a belt from near the Urals to a deposit in Persia, halfway between the European and the Central Asiatic iron belt, or about 45° distant from each of these.

(*d*) Dana mentions some iron in the region of San Francisco, which would be about 45° west of the Pennsylvania portion of the main United States belt.

2. *Manganese.*—The localities given by Dana for this metal would fall almost, if not entirely, within the iron belts of North America and Europe, showing a similar tendency to assume a paramagnetic direction.

3. *Platinum.*—The chief localities of platinum, as given in Dr. Dana's "Manual of Mineralogy"—namely, the Ural Mountains and New Granada, South America, as well as Canada and North Carolina, where traces have been found, fall within the United States iron belt. Borneo, and places in Minas Geraes, Brazil, where some platinum has been taken out, are very slightly east of the above-named belt.

4. *Nickel and Cobalt.*—Ores of these metals are found, according to Dana, in Cornwall, Sweden, Norway, France, Saxony, and the United States (Missouri, North Carolina, Pennsylvania); all again within one or other of the paramagnetic iron belts. Some nickel found in New Caledonia would occupy a position very nearly halfway between the iron belt of Central Asia and the iron of California.

Without going into further details at present regarding the paramagnetic metals and their ores, let us examine some of the

II.—DIAMAGNETIC METALS AND THEIR ORES.

1. *Gold.*—This metal cooling among the first on the globe is found in old formations, but appears to be also injected into, or deposited in, the fractures and fissures of rocks having a more recent age. The earlier east and west ranges or belts, in which it occurs more or less, often correspond, as already stated, with parallels of latitude; thus we find gold on a belt of the parallels 55° to 60° N. lat., comprising the gold of Alaska, Scotland, Sweden, and the Urals; again, in a belt ranging from lat. 45° to 50° N., embracing the gold of British Columbia, Washington Territory, and Oregon, of Lake Superior, Canada, and Nova Scotia, in North America.

We find on the same parallels or belt, in the eastern continent, the gold of the Alps, Tyrol, Hungary, and the Altai Mountains. Another zone or belt, in about lat. 35° to 38° N., runs from California and Arizona, through Georgia and North Carolina, and is prolonged through Spain, Thibet, China, and Japan. A more southerly belt marks the gold of Central America and New Granada (United States of Colombia, S. A.), also of Western and Eastern Africa (about 5° N. of the Equator), as well as of Ceylon, Java, and Borneo. The most southerly belt, in about lat. 22° to 32° S., embraces the South American gold localities, the gold washings of South Africa, the rich mines of Australia, and almost includes the gold of New Zealand.

In some cases, without making the belt so broad, gold localities can be traced on one and the same curve, using either the northern focus of each continent for a center, or occasionally the more southern continental focus. For instance, using the Boothia Felix focus as a center, an arc unites the gold of Oregon with that of Canada, while from the Lake Superior focus a curve sweeps from the gold of the Sierra Nevada and the Sacramento Valley in California to that of Georgia and North Carolina.

2. *Silver.*—The most noted localities for this useful metal can be readily traced in North America, Europe, and Asia, on belts running east and west, often at vertical intervals of about 4° to 5° apart, or say every 300 statute miles. Thus we have a belt from the silver of Norway to that in the Urals; then another, from Montana, Idaho, Wyoming, and

* From a paper read before the American Association, 1880.

† Although lead is found sometimes in silurian and carboniferous rocks, yet Dr. Dana shows (at page 148 of his Manual of Mineralogy) that such is not its true age. Speaking of galena, he says: "In Derbyshire, England, the deposits contain fossils of permian rocks, showing that, although occurring in subcarboniferous limestone, they were much later in origin."

* A degree of longitude in latitude 40° is about 53 statute miles; consequently the width of the belt is nearly 750 miles.

† The average latitude of European iron being about 54° to 55° N., we may call a degree equal to 40 statute miles, thus giving the above result.

Lake Superior regions, continued through England, France, and Saxony to the Altai Mountains. A third silver girdle runs from California and Arizona, through Utah and Colorado, thence to Spain. A fourth shows that of Mexico on the same parallel with the silver of China. Then come the rich mines of South America, in three successive belts (that of Venezuela, of Brazil, and of Bolivia), with nothing to correspond in the eastern continent.

3. *Copper* can equally readily be traced along belts on diamagnetic parallels; such as one in Scandinavia connecting with the Urals. A second, on the parallel of the rich Lake Superior region, takes in the copper of Cornwall, of France, Thuringia, Hungary, Siberia, China, and Japan. A third can be found embracing the mines of Arizona, New Mexico, Tennessee, and North Carolina, also of the Island of Cyprus, of Turkestan and Persia. A fourth gives us the copper of Cuba, Africa, Arabia, and Hindostan, as shown in map No. VIII. of Cornell's Phy. Geogr., by Steinwehr. Of the two copper belts in S. America, the more southerly is on the same parallel with the copper of Australia.

4. *Tin*, although sparingly distributed, except in two or three localities, follows the same rule: First belt, Massachusetts, New Hampshire, Cornwall (England), Saxony, Austria, and Russia. Second belt, California and Spain. Third belt, Durango (Mexico), Peru, and China. Fourth belt, Malacca and Banca. Fifth, Bolivia (S. America), Queensland, and Northern New South Wales, in Australia, in about the parallel of 22° to 23° S. Lat.

5. *Lead.*—The diamagnetic arrangement of the localities in which this metal is most abundantly found may be rendered equally apparent, whether we follow the galena and other ores in belts, on parallels around the globe, or connect these metallic deposits by curves from the Boothia Felix focus, for North America, and the Scandinavian focus for Europe. Thus, first belt in North America, from Arctic focus, Idaho, Wisconsin, Iowa, Northern Illinois, Vermont, New Hampshire, and Maine; second belt, Nevada, Utah, Colorado, Missouri, Southern Illinois, New York, Connecticut; third belt, California, New Mexico, Arkansas, Tennessee, and North Carolina; fourth, Fort Yuma and Arizona; fifth, the argentiferous galena of Mexico.

In Europe there are from the Scandinavian focus four belts: first, that of Scotland and Saxony; second, of England and Bohemia; third, the lead mines of France; fourth, those of Spain, often argentiferous.

6. *Zinc.*—From the Scandinavian focus we trace one curve, which marks the zinc belt of England, Belgium, and Germany; another that of France and Austria. In Asia, from the North Siberian focus, a belt connects the zinc of the Altai mountain with that of China. In the United States, if we take the Lake Superior focus as a center, we can bring within one belt the various zinc ores of Tennessee, Virginia, Pennsylvania, and the abundant deposits of New Jersey, as well as the zinc localities of New York, Vermont, New Hampshire, and Maine.

7. *Antimony.*—From the Lake Superior focus, a semicircle unites in one belt the ores of antimony found in Maryland, New Hampshire, and Maine, while just outside is a curve or zone uniting the mines worked in Sonora (Mexico) with those of New Brunswick.

In Europe, with Mount Rosa for a center, the tertiary circles (radius 9°), described in the former communication, passes through the zinc of Cornwall (England), of Spain, and of Hungary.

8. *Bismuth.*—A belt in the United States, with Lake Superior for a center, unites the bismuth found in Montana, Arizona, and Colorado, with that of Georgia and South and North Carolina.

In Europe the bismuth of Norway and Sweden are in one curve from the Scandinavian focus; that of England, Saxony, and Bohemia constitutes a second curve. Bismuth is also found in Australia, nearly on the parallel of latitude on which it is obtained in Chili and Bolivia (South America).

These demonstrations, or coincident facts, may perhaps suffice to test the truth of the law, which appears to be similar in character to that governing the formation of land.

Metals and metallic ores would seem, then, most frequently to have arranged themselves, particularly when diamagnetic, as a large majority of bodies are, in curves, equidistant from some dynamic focus.

It is hoped the above generalization may aid the miner and mineralogist in their search after mineral wealth.

UNDERGROUND TEMPERATURE AND WATER.

MR. SUTRO, of tunnel fame, in a recent address before one of our scientific bodies, said:

One of the greatest obstacles encountered in the working of these deep mines of the Comstock lode is the presence of water, which is found in great quantities—and hot water at that. Gentlemen have different ideas about this water, and how it gets so hot. I have, from my own observations, formed my own ideas about it. I do not think, as is contended by many, that this water is heated by chemical decomposition. My theory is, that the water from rains and the melting snow upon the Sierra and Nevada Mountains rapidly descends through the fissures of the crystalline rocks (and as they generally incline at a sharp angle, the water descends very rapidly), until it reaches a depth of several miles. We know (although by some it has been disputed) that the increase in heat is about one degree of Fahrenheit to every sixty feet of descent. I think that this has been demonstrated all over the world. Of course, there are instances where this is not the case; but those are the exceptions. On the Comstock lode this rule does not strictly apply, because the heat increases much faster as you descend. There at the depth of 1,400 or 1,500 feet, the mercury rises to 110°; and at 2,800 the temperature of the work is as high as 130°; and at 2,800 or 3,000 feet, it is as high as 150°. I have observed this matter for many years, and have looked into it pretty closely, and my idea is, that this water descends from the Sierra Nevada Mountains to a depth of 10,000 to 15,000 feet; that it is there converted into steam, and finally into superheated steam. Of course, there is then exercised an upward pressure which does not permit any more water to descend, because the pressure of the descending water is counterbalanced by the pressure of the superheated steam. I recollect that I had, a few years ago, a controversy with Professor Sterry Hunt (probably the best informed man on this subject in the United States) and some other gentlemen; and his idea was, that if there was so great a pressure down there, the steam would thereby be again converted into a liquid. But I do not think that bears upon my theory at all; because if the steam is reconverted into a liquid by the immense pressure, it would become steam again upon lessening or removing the pressure. If, therefore, the water descends until it becomes heated to a boiling point, it may then ascend, either because of capillary attraction or of pressure; and as it finds its way upward through the crevices of the rocks, it necessarily heats the rocks by the contact. And here it is where mistaken ideas come in; the rock does not heat the water at these higher points, but the water heats the rock. It seems to me quite evident that as the water permeates all the cracks and fissures of the rock, the rock itself must thus become heated. Of course, the water loses some of its heat in its ascent. If we could go down 3,000 feet deeper than we now are, we should find boiling water. It is now 165° in some places.

THE EARLIER MIGRATIONS OF ANIMALS AND THEIR RELATION TO THE PRESENT DISTRIBUTION OF ANIMALS.*

By CARL VOGT.

IN order to understand the importance of animal migrations which must have taken place during earlier geological epochs, we would have to compare the present geographical distribution of all types with the distribution of those types which we find in the deposited strata of our globe. That would be a giant task for which, besides, to say the truth, many of the necessary elements are still wanting; for our knowledge of the distribution of animals in the earlier periods is still less defective than that regarding our present faunas, and how limited is our knowledge of the latter I have endeavored to show in several other places. I will in this essay, therefore, speak only about the land mammals, and I refer, as far as regards the present distribution of this group, to the excellent work of Alfred Russel Wallace, entitled "The Geographical Distribution of Animals," which has been translated into German by Meyer.

Wallace discerns, regarding the distribution of animals upon the earth, six great regions, which are again divided into several sub-regions. These regions are: 1. The Palearctic Region, which includes Europe, with the whole surroundings of the Mediterranean Sea and Asia, from the northern slope of the central mountain chains. 2. Ethiopic Region, comprising Africa, south of the Atlas Mountains, Southern Arabia, and Madagascar. 3. The Oriental Region, comprising Asia, south of the Himalayas, Ceylon, and the Sunda Islands, as far as Timor. 4. The Australian Region, comprising Australia, New Guinea, and the other islands south of Timor. 5. The Neotropic Region, comprising South America, as far as the Isthmus of Panama. 6. The Nearctic Region, comprising North America, from the Isthmus of Panama north.

The limitation of greater regions for faunas is always somewhat arbitrary and disadvantageous—first, on account of the mixture of types on the borders of those regions, and, secondly, on account of the difference in the distribution of different species—tiger and specter monkey (*Tarsius spectrum*)—belong to the same Oriental Region; but while the former may be found from the southern extremity of India to the shores of Amur, in Siberia, the latter is limited to a few islands. Therefore the limits of each region will be larger or smaller, according as we attribute more or less importance to the one species or the other.

If we neglect this and similar objections less important, we must acknowledge that each of the regions of Wallace includes animals of a specific character. Viewing only the present distribution of animals, it might be said, perhaps, that Wallace gives too few regions. So, for example, Madagascar, as well as the polar regions of both continents, can be considered as separate regions; but when we view chiefly the earlier distribution of animals from which our modern creation has been developed, it will be evident that the specialization of the above-named regions goes too far, for the three main regions into which the Old World is divided are much more closely related to each other than Madagascar to Africa. Both of these, by Wallace, are brought under the sub-region of the Ethiopic main region.

But whatever may be said in regard to these limitations, to which we will return later, one thing cannot be denied, viz., that the present distribution of land mammals can never be considered an independent fact, standing alone, but has, as a necessary consequence, been developed from earlier geological epochs, which we are able to follow backward to the oldest tertiary strata. But beyond this strata our knowledge does not extend. We know absolutely nothing about the animals which have lived during the deposition of the cretaceous strata—very little about those which lived during the Jurassic and Triassic period up to the time of the "bunte sandstein"—and we would be obliged to fill the gaps in our knowledge with creations of our fancy, but we prefer to leave such sport to those who feel inclined to it.

The present condition of our knowledge does not permit us to accept special centers of creation, nor to suppose that there existed single prototypes from which these types have developed. This assertion, which is in direct opposition to the views held by Haeckel, I will try to prove by an example.

The ruminants form a well-defined order of our land mammals; they are found in unmistakable species and genera up to the middle tertiary formations, the miocene strata. In the older tertiary strata there are types which incline toward them. The genus *Oromeryx*, from the American eocene period, which, by Marsh, an eminent scientist of the United States, is considered, although somewhat doubtfully, to be the progenitor of the deer, is just as little a genuine ruminant as the *Xiphodon*, which is of the same period, and which is found in the gypsum layers of the Montmarte, near Paris. Mr. Gaudry, Professor of the Jardin des Plantes, says that this animal may be just as well counted among pachydermata as among the ruminants. Which, now, of these two genera is the progenitor of the ruminants? Where have we to look for the center of creation of the ruminants—in Europe or America? The ruminants have in the half-mooned shape upper surface of their teeth a peculiarity, on account of which they have received also the name Selenodontes; but this Selenodontic type is also found among those pachydermata of the eocene period, which have an equal number of toes. Which of these genera has transferred this character to the ruminants? Either of them, and neither of them, may be answered. The same difficulties exist regarding the ruminants of the older miocene period. Kowalewski, who has published such beautiful studies regarding them, declares a small species (*Gelocus*), found in Auvergne, in France, to be the progenitor of the ruminants; but Marsh, in America, and Gaudry, in Europe, enumerate dozens of genera which have at least the same claim. "Our difficulty," says Gaudry, explicitly, "consists in the choice. As regards the number of teeth (or the horns), the pachydermata are so nearly related to the ruminants that it is impossible to designate those species of the pachydermata, which should justly be considered the progenitors of the ruminants." So much for the progenitors of the ruminants.

Now, as regards their center of creation, the ruminants are distributed all over the earth except Madagascar and Australia; but during the periods of the eocene and miocene the genera of ruminants, or of types similar to them, are in the Old World very different from those in the New World, so that Europe and America in this regard did not differ less than they do to-day. Where, then, did the ruminants originate, and in what manner did they come from their center of creation in the one continent to another continent? According to Marsh, the family of the camels has been developed from the *Parameryx*, a type which is found in the upper miocene strata of America. Can we now assume that the camels during the miocene period wandered from North America to the Old World? That the llamas wandered to South America, while the sheep and goats remained in the Old World, and the antelopes sent only a single representative, namely, the (*Gabelgemse*) fork-chamois, to the Rocky Mountains of America?

Let us now consider the facts more closely. According to Marsh, the genus *Parameryx*, from the upper eocene of America, is the progenitor of the camel, to which it is the most closely related, and, being the oldest genus, it would also be the progenitor of all ruminants. The successors of the *Parameryx* could not emigrate to South America, for the reason, as Marsh himself acknowledges, that the Isthmus of Panama stood there under water, and did not rise from the flood before the end of the tertiary period. These successors, therefore, would have migrated East and West, and during the miocene period would have produced all those families of ruminants, which, with the exception of the goats, are found in that period. Dwarf deer (*Tragulides*), musk oxen, deer, giraffes, oxen, sivatheridæ, which have now died out—all those living and fossil families—would, according to the theory of monogenists, have developed in the Old and New Worlds from the single progenitor *Parameryx*. But only a few of these successors would have returned to America during the pliocene period, where, meanwhile, the llamas had developed, which, later, wandered toward the south along the Rocky Mountains. The deer would have followed; the dwarf deer, giraffes, sivatherides, the antelopes (with the sole exception of the fork-chamois) would have remained in the Old World; and the sheep and oxen would have been delayed during the migration, and would not have arrived until a much later time.

What difficulties! What crowding of improbabilities! But all those difficulties fade as soon as we assume that the ruminants have developed from different types, which correspond to their families and sub-families. Why should not the camels of the Old World have developed from a special species? Why should not the dwarf-deer and the musk oxen and the antelopes have descended from the pachydermata, which were aborigines of the Old World? There is plenty of room for migrations left. The bison, the reindeer, the elk, the musk ox, etc., have migrated hither and thither between the Old and New Worlds during the pliocene and the post-pliocene period! But while these genera and species are identical, and can scarcely be considered as varieties, we have, during the miocene and the earlier pliocene period, not a single genus which is common to both continents, a fact which would be unexplainable had so many migrations occurred, as we would be obliged to assume, if the theory of a single center of creation were correct.

From this and a great many other facts we may draw the conclusion that the geographical distribution of animals that are nearly related to each other, and which although belonging to the same order of mammals are found in regions very remote from each other, does not prove anything for the theory that migrations have extended from a certain center; nay, we have much more reason to assume that the distribution of these animals is the result of a development which took place simultaneously in different portions of the globe, and which originating from different roots, creates family trees, the branches of which, proceeding from the different trunks, incline toward each other, and do not, as the above named theory assumes, deviate from each other. Nothing is easier than to construct imaginary bridges and viaducts, by which continents were connected which at present are separated by the sea, or to invent sunken continents, the tops of which it is said may be seen as islands projecting out of the sea. The only question is, whether such theories, often presumptive as they are, justify or even necessitate the conclusions based upon them. If we compare the faunas of earlier periods with those which we see on our earth to-day, and if we at the same time consider the differences existing between the regions of distribution, two regions suddenly strike our eye which have a peculiar physiognomy, viz., that of Madagascar on the one side, and that of the Australian continent, with its appendix of Van Diemen's Land, on the other side.

Let us now first look at Madagascar, which Wallace considers only a sub-region of the Ethiopic main region, while Haeckel and others try to make out of this East-African continent the remainder of a wide continent called Lemuria, and which, they say, was drowned in the sea, perhaps as a punishment for the production of such an ungovernable creature as man.

In Madagascar only six orders of the land mammals are represented, viz., half-monkeys, bats, insectivorous animals, carnivorous animals, rodents, and (artiodactyls) the hoofed animals are represented by only one genus of hogs (*Potamochærus*), the carnivorous by only a few small genera, while three others are represented by numerous genera and species.

Let us now look at the several land mammals separately, as far as regards their relation to supposed migrations. The *bats* can throw no light upon this question. The fruit eating, flying-dogs are extended over the whole tropic zone of the Old World; the horseshoe noses are found everywhere; the molossi inhabit the whole tropic zone—all these animals fly splendidly, and can therefore easily fly over the arm of the sea which separates the island from the continent. Besides, the bat belongs to the oldest nobility of the mammals, their ancestors being already found during the eocene period. If, therefore, during the latest cretaceous period, a connection existed between the island and the continent, the ancestors of the bat might have walked across.

The *river-hog* (*Potamochærus*) is an excellent swimmer, and spends half his life in water. A species similar to that found in Madagascar lives at the neighboring coast of the continent. But the pedigree of the hogs is still older than that of the bats—and already in the cretaceous period animals with evenly paired toes must have existed.

The origin of the *insectivorous animals* can be led back to the eocene period. Besides some shrewmice, species of

* Translated for the SCIENTIFIC AMERICAN from Westermann's *Monats-hefte*.

which are found all over the earth, there still exists in Madagascar a peculiar family similar to the hedge-hog, called centetides, which are found nowhere else on the earth. An effort was made to bring this family in connection with a peculiar insectivorous animal of the Antilles (*Solenodon*) and to discover its relation to a fossil genus found in the miocene strata of Southern France; but neither of these attempts is based on a solid foundation, and a separate place must be given to the Madagascar hedge-hog.

The *native rodents* belong to the family of mice extended over the earth, but the species found there are peculiar to Madagascar, and can be found nowhere else.

Similar is the case of the *carnivorous animals*. A peculiar animal, *Cryptoprocta ferox*, forms a separate family; the remaining smaller carnivorous animals belong to the family of the martens and of the civet-cats, which are found nearly everywhere on the globe, and which originated during the eocene period, descending also from the oldest carnivorous animals.

There remain only the half-monkeys or *lemurides*, of which Madagascar alone has more native genera than all the other continents together. For this reason the island may perhaps be called Lemuria. There exist half-monkeys, it is true, in tropical Africa, East India, and the Malayan Archipelago, and upon this fact was based the supposition that Madagascar had a connection with the countries of the tropical zone toward the East and West. But we must not forget that all the families, sub-families, genera, and species found in Madagascar are peculiar to that island. The indris (*Lichanotus*), the genuine makies or lemurs, the aye-aye (*Chiromys*), inhabit Madagascar exclusively; the loris (*Stenops*) and specter-monkeys (*Tarsius*), East India and the Sunda Islands; the pottos (*perodicteus*) and galagos (*Otolicnus*), Africa; and in none of these regions of distribution are found genera similar to those of any of the others. If, therefore, we were to make the assertion that a connection must have existed between these countries, because that the same order of mammals is found in them, we would also have to assume that the Cape of Good Hope has been connected with South America, for the ground-hog (*Orycteropus*), which is found in the former country, as well as the armadillo, which is found in Brazil, belong to the family of edentates.

In the eocene of the Old World, as well as that of the New World, but especially in the latter, a great number of very curious genera has been found, which, contradictory to all views previously held, establish a connection between the half-monkey on the one hand, and the hoofed animals or pachydermata. Ten years ago no one would have been able to divine such a relation. But while in America no genuine fossil half-monkey has, as yet, been found, such an animal has been discovered in the phosphorite layers at Quercy, in the southwestern part of France. It belonged to the eocene period. Filhol, who has examined this fossil-animal, and who in his description calls it *Necrolemur*, maintains that it is closely related to the African *Galagos*, and that it has only a slight relation to a genus living in Madagascar, *Lepilemur*.

If now collecting all these facts together, I conclude that Madagascar is inhabited by only such land animals the pedigree of which can be traced back to the eocene period, that even those families which are spread all over the globe, and which are represented on that island, as the insectivorous bats and the mice, belong to this old eocene nobility, and that Madagascar, at least since that time, must have been separated from the continent—this being the reason that its fauna has developed in a manner quite different from that of other countries.

That this separation has lasted during the whole tertiary period cannot be doubted. None of those orders of animals which originated during the miocene period are found on that island; even those orders which spread all over the globe or at least over the neighboring continents of India and Africa, are altogether wanting. In Madagascar there are no monkeys and no hedge-hogs, no cats, no hyenas, no dogs and no bears; rhinoceroses are wanting just as well as elephants and hippopotami, and we would look in vain for ruminants or horses.

But all those above named orders and families are found in those neighboring countries with which Madagascar is said to have been connected; some of them are there in abundance even and undertake yearly migrations. It would be really incomprehensible why cats, hyenas, and dogs have not followed the herds of wild goats and other animals to that island, if there had been a connection existing between it and the continent.

We may even go further. Madagascar and Australia are the only countries in which certain descendants of the old eocene ancestors are wanting, which are found everywhere else, and the ancestors of which are found also in every place where it was possible to examine the oldest tertiary period. The dogs, among the carnivorous animals; the perissodactyls, to which rhinoceroses, tapirs, and horses belong; the squirrel among the rodents, all have originated in the eocene, and have since that time developed in both hemispheres, but are altogether wanting in Madagascar. I want to draw attention to the fact that the oldest perissodactyls (*Coryphodon*) are found in the lower eocene strata of both hemispheres; that the relatives of the tapir of the eocene are abundant on both of the shores of the ocean; that the direct modern descendants, the tapirs, are still to-day found in South America, East India, and the Sunda Islands; we may even say that there exists no country in the world, with the exception of Australia and Madagascar, where since the eocene period there have lived no perissodactyls; for even Africa, although it has no tapirs, possesses rhinoceroses and horses in abundance. How happened it that types so generally diffused have been excluded from Madagascar? Why has not the great fauna of the tropical Africa been distributed over Madagascar, just as that of East India has been over Ceylon? Of the even-toed animals there exists only the family of the hogs, which has been but little differentiated during the evolution, and the only representative of that order, the *Potamochærus*, may just as well be the final result of a development which took place on the island itself as that of migration, although such migration may even have taken place before the eocene period.

Indeed we could even lead these facts back to the tertiary formations, and justify the assumption that the separation of Madagascar from the continent took place already before the deposits of that period had been formed, *i. e.*, during the end of the cretaceous period. But before we can make such an assertion, we must wait for further proofs, which could be found by geological investigations of the neighboring continent and of the island itself. The facts hitherto obtained permit only a conjecture of that kind. But they are perfectly sufficient to be an undeniable proof that all those hypotheses which maintain that there existed a continent connecting during recent periods Madagascar with the continent, and that this continent was the cradle of the human race, are nothing else but fancies which have no actual foundation, and the beautiful Lemuria, with its grand forests in which our ancestors climbed from tree to tree, had scarcely ever any other existence than that which it has now, viz., the bottom of the sea.

Summing up the results of this investigation, Madagascar appears to me as a zoographic region which has been independent since the eocene period, and to which there have been immigrations, but from which no emigrations have proceeded. This great island offered sufficient space for the struggle of existence to permit the development of some older placental mammals, but this development has not been able to continue for a long time, but stopped at the beginning of the miocene period.

Australia leads us to still more striking conclusions. With exception of the dingo, the so-called native dog of Australia, which was probably introduced by man, we find upon the whole Australian continent (Tasmania included, which only recently has become separated from it) only two orders of placental mammals, the bats and the rodents—both old types, the origin of which may be traced back to the cretaceous period. As regards the bats, we find, with exception of the noctilionides, all families which are already present in Madagascar. The rodents are represented by three genera, which are found only in Australia, which belong to the family of the mice, that is spread all over our globe. The genus *Hapalotis*, which is represented by thirteen species, seems to be the typical form of that continent. The bats may have immigrated to Australia even more easily than to Madagascar; the mice may have immigrated or may have been directly developed from original types that belonged to the opossums; the first supposition seems to be the more probable.

The geography of the Australian mammals is limited, therefore, to the opossums and monotremes. Of the former we know that their origin may be led back to the triassic formations of both hemispheres, while the only two representatives of the monotremes, in regard to their present exhibition as well as their earlier existence (which cannot be traced farther back than to diluvial formations of their country), are exclusively Australian types.

Different is the case of the opossums. One single family of them (*Didelphyida*) is found exclusively in South America, Mexico, and the Southern part of the United States; all other living families belong to Australia. *Myrmecobius* and *Phascolomys* are found upon the continent only. The fossil opossums found in the triassic strata are very similar to the former kind. This little animal, therefore, belongs to the oldest nobility of the mammals.

If I except the two above-named genera, which form families for themselves, and the American opossum, the remainder of the opossums consists of 4 families, 31 genera, and 123 species. 24 genera, comprehending 83 species, live exclusively upon the continent; 3 genera, having together 5 species, inhabit only the islands belonging to the Australian region; while 3 genera, with 37 species, are common to both. Among those which inhabit the islands exclusively we mention the so-called tree kangaroo (*Dendrolagus* and *Dorcopsis*), and the genus *Myoictis*, belonging to the carnivorous *Dasyoides*. Those genera which are found upon the continent, as well as upon the islands, belong to the carnivorous animals, to the *Peramelida* and to the *Phalangida*.

Comparing the present distribution of opossums with that found in the geological strata, we discover that the family of the opossum, which at present exists exclusively in America, is found as a fossil family in the strata of America and Europe. It, therefore, can not be doubted that this type is perfectly occidental, that the American-European opossums found in the eocene strata are by no means ancestors of the Australian opossums, and that they must be considered as perfectly separate branches of an older kind. I am, therefore, of the opinion, which is defended by Wallace, viz., that the Australian opossums have nothing in common with the American opossum.

The Australian continent, consequently, must have been separated from America at least since the eocene period, and it must also have been separated not only from the other continents, but from the Malayan archipelago, Celebes and Timor included, while New Guinea and the neighboring islands were probably connected with it. How else would it be possible that all placental mammals, except bats and mice, have been excluded from the Australian continent and New Guinea, while monkeys, hogs, rapacious animals, squirrels, and oxen have come as far as Celebes, and deer even as far as Timor? On the other hand, only a few phalangida (*Cuscus*) are found as far distant from Australia as Celebes and the Moluccas, and their immigration may have taken place very recently, perhaps they have been introduced by man.

These facts force us to the conclusion that the above named countries were separated, at least since the tertiary period, and that East of New Holland and New Guinea the development of mammals has never extended beyond the opossums. For the reason, now, that higher developed placental mammals are found already during the oldest eocene period, the separation must date from the cretaceous period.

The only question which stills remains is the relation of Australia to New Guinea. Have these continents been connected so that migrations may have taken place, or were they separated, as at present, by the Bass Strait? A conclusive answer can not yet be given. But it seems to be very probable that the separation took place as early as the tertiary period.

However, this question is of little importance in comparison with that treated above, viz., the separation of Australia and New Guinea from the other continents.

From the facts already stated, we will see that migrations and locomotions have been of little importance in the regions of Australia and Madagascar. The primitive faunas of both countries could not extend beyond the arms of the sea which separated them from the other countries, and immigrations and migrations were prevented by the broad stretches of water. These faunas, therefore, represent pure progenies, which developed and differentiated themselves in those countries during different geological periods without coming in contact with the fauna of other countries.

Very different is the case regarding the animals which at present people the great continents of our globe, the Old and the New World. All zoological geographers have accepted different limits of distribution, of which I do not intend to speak in this place. I will only draw the attention to the limitation accepted by Wallace, which I have indicated above.

May we, with modern zoological and paleontological facts as a basis, speak about different centers of creation, which correspond to the zoological provinces from which the different types have become expanded? Or have we any reason to accept a single center of creation for all those faunas?

Assuming the latter hypothesis, we have necessarily to accept also a single ancestor for all mammals, Haeckel's so-called *Promammale*; and this primitive mammal, which, being a descendant of the amphibranx, has to represent all characteristics of the amniotes in general and the mammals in special, cannot be placed in a later period than that of the lower triassic strata, or even in that of the paleozoic group. For the reason that undispatable remainders of opossums, which belong to different genera, have been found in the triassic strata of both continents (*Microlestes* in Southern Germany, and *Dromotherium* in America), we have to assume that the original type must have existed during a very distant period, for only in this case its successors had time to migrate around half the world, *i. e.*, from Europe to America, or from America to Europe, and to produce different genera by differentiation.

Whoever thinks this probable, or even possible, may believe it. As yet all facts are wanting which would enable us to give a definite opinion.

In the same manner, all facts regarding the development of mammals during the triassic period are wanting. In the jurassic strata (of England and America) also some opossums have been found. These may give a hint regarding the developments of the types of the opossums themselves, but they throw no light upon the migrations and expansion of mammals.

Our actual knowledge does not extend beyond the eocene period, although it has been greatly expanded recently by the beautiful discoveries of the Americans regarding the tertiary strata on both sides of the Rocky Mountains. O. W. Marsh has summed them up in his very valuable essay, "Introduction and Succession of Vertebral Life in America;" Gaudry has treated on the European mammals in his beautiful work "Les enchainements du monde animal: Mammifères tertiaires. Paris, Savy, 1878," and Filhol has increased our knowledge by his studies of fossil remains of the phosphorites of Quercy, which he has laid down in his work, "Recherches sur les phosphorites du Quercy. Paris, Masson, 1877." Especially by the aid of these three works, besides the older works, I have made a list of all families and genera of land animals found in the different strata of the tertiary period. This list is necessarily incomplete, and perhaps even incorrect, because the forms of the phosphorites attributed to the upper eocene probably contain animals belonging also to the miocene period—but it serves at present its purpose.

I find, first, a certain number of orders and families which have been identified in the eocene strata on both sides of the ocean in Europe as well as in America. The half-monkeys are represented in both continents by peculiar transition forms, forming a connection between hoofed animals and half-monkeys, and called by Filhol *Pachylemures* and *Pachyæmiades*; by Marsh, *Lemuravides* and *Limnotherides*. Upon both hemispheres there exist during the eocene period, bats, insectivorous animals, carnivorous animals, perissodactyls, even-toed animals, rodents, and opossums. But only in the Old World monkeys have been found, while in the New World very peculiar types, called tillodontes, dinocerates, brontotherides, etc., have been discovered, which have become extinct.

I count during the eocene period 70 genera in the Old World, and about the same number in the New World.

In both hemispheres there have been found only three genera which belong to the perissodactyls, viz., the genus *Coryphodon*, a great animal of which we know no descendants in the lower eocene layers; the genus *Lophiotherium*, in the middle and upper eocene strata; and the genus *Chalicotherium*, in the uppermost strata of the eocene period. The last two genera belong to the animals which resemble the tapir. Europe possesses 67 different species, and America about the same number.

Considering these numbers, can we believe that both hemispheres have been connected during the eocene period, so that the land mammals of the one continent could have wandered to the other continent, becoming more and more modified in the course of time? The rapacious animals which are so fond of migrating are, in both continents, represented by numerous genera; the family of the hyenodontes, the characteristics of which have been so differently described, on account of their teeth, which have a great similarity to those of the opossums, are represented in both hemispheres in great number, but not a single genus is found which is common to both of them. The same fact is true in regard to the bats: although they are able to fly over large distances, their genera are different in the two hemispheres. In America as well as in Europe are found numerous genera of those families that stand between the half-monkeys and hoofed animals—none of them is identical. In the phosphorites a half genuine monkey has been found. Nothing similar to him has been detected in America, where the half-monkeys have been wanting at all times and are wanting still. The dogs and civet-cats have representatives in the eocene strata of both hemispheres, no genus of them being common to both. The same holds good for hogs and rodents. Our anoplotherium is wanting in America. The American brontotheria, oreodontes, tillodontes, and dinocerates are not found with us. Although America alone, according to Marsh, has in its eocene layers the ancestors of the horses, of the camels, and the deer, we must not forget that we also possess a series of fossil animals which constitute the ancestors of the horse in their gradual development, and which, although not being as old as the American series, found in the lower eocene strata, nevertheless begin with the independent genera, *Antitherium* and *Anchilophus*. The tapirides, finally, have, besides, the above-mentioned genera, which are common to both hemispheres, a number of other genera which are peculiar to one or the other countries. It is possible that the three above named perissodactylic genera, which are found in both hemispheres, have originated in common ancestors; but if this is the case, those ancestors must have lived in the oldest cretaceous period, *i. e.*, in the hypothetical times of which we know nothing. But, however this may be, all other facts prove that during the eocene period no migrations between the two hemispheres can have taken place, and that the different genera in each of them have developed independently. We cannot know, as yet, whether the enumerated orders, families, and genera have descended from a single ancestor during the cretaceous period or from separated progenitors; but one thing we must consider to be a scientific fact, viz., that the mammals during the eocene period developed independently, although often in a parallel direction.

Besides, we may well say that certain facts lead by analogy to the assumption that different progenitors have existed from which successors have been developed, the course of development having a convergent direction of the branches of the different stems, so that the latest progenies

of the orders in both hemispheres have a great similarity to each other (we mention only the development of the horse in Europe and America).

Let us now go back to our starting-point. I see no reason why we shall believe that the three genera common to both hemispheres have immigrated rather than developed where they are found, while 67 genera evidently are the result of a native development.

I must not forget to acknowledge that all our conclusions are made difficult by the insufficient paleontological material.

We know, at present, only the fossil remains of the eocene strata of Europe and America, and it might be that later discoveries, especially in the tropic regions of Asia, Africa, and America, will transform the basis of our views.

Before speaking of the miocene period, it will be well to consider the relation which exists between the animals still living and those found already in the eocene strata.

If we consider Europe, as we at present must, as the representative of the Old World, I find that of all families which lived already during the eocene period and are still existing, only one, that of the opossum, has disappeared from our continent although continuing its existence in the New World. Other families already present in the eocene period of Europe, viz., the *Catarrhines* (small-nosed monkeys), the genuine night monkeys, the horseshoe-nosed bats, the "speck-mice," the moles, the civet-cats, dogs, horses, tapirs, hogs, mice, rell-mice, squirrels, echimyida still exist in the Old World; the monkeys, night monkeys, and echimyida, it is true, have withdrawn to Africa, and the tapirs to East India.

In the eocene strata of North America about the same number of still living families (16) has been found, but their final fate has been somewhat different. Moles, cats, dogs, hogs, deer, mice, and squirrels live still to-day in both Americas; the *Solenodon*, that peculiar insectivorous animal of the Antilles, which perhaps belongs to the (*Centetides*) urchins of Madagascar, the tapirs and the camels are found at present only in South America; civet-cats, horses, and rhinoceroses on the other side have become extinct in America, while they continue their existence in Europe, where the former two families existed already during the eocene period, while the latter first appeared during the miocene epoch. The echimyida and opossums, on the other hand, which live at present in America, have not as yet been found in its eocene strata, and, therefore, seem to have originated in the Old World.

The number of families and genera of land mammals increases greatly during the miocene period. The deposits of this period, especially during the renowned discoveries at the Sivalik Hills at the foot of the Himalayas, and at Pikermi in Greece, furnish excellent material for comparative studies in paleontology. We could, therefore, set up a much more complete list of families, but I frankly admit that my knowledge is not sufficient to classify the rodents of the miocene period. I omit this order, therefore, in the following, and only mention that the rodents have numerous representatives in the miocene deposits, and that, perhaps, all the families which at present live in both hemispheres existed in the miocene period of those countries.

Regarding the rest of the land mammals, I find that twelve families which originated in the miocene period exist still in all parts of the globe. Four of them, cats, dogs, hogs, and deer, are found in the miocene strata of both hemispheres; two of them, martens and hollow-horned ruminants, in those of Europe and Asia; one of them, the urchin, only in those of Europe and America; four of them, finally, "speck-mice," horseshoe noses, moles, and shrew-mice only in the miocene strata of Europe, while the bears exist only in those of Asia.

Two families, the "sea cats" (*Semnopithecus*) and civet cats, live only in Europe, Asia, and Africa. The former family originated in the miocene of Asia and Europe, the latter in that of Europe.

Asia and Africa have seven families in common, two of which, the rhinoceroses and horses, are found in the miocene strata of both hemispheres; the anthropomorphic monkeys, the hyenas, the trunked animals, which are present inhabitants of Asia and Africa, developed during the miocene period of those countries, the camels originated in Asia and America, the baboons only in America.

Europe and America have no family of the miocene period in common; Asia and America are inhabited by tapirs, which originated in the eocene period of both countries.

The tenrecs (*Tupajida*) and the dwarf deer (*Tragulida*), which originated in the miocene of Europe, to-day live exclusively in Asia; the hippopotami, which developed in the Asiatic miocene; the giraffes, which originated in Europe and Asia, and the ground-hog (*Oryctoropus*) coming from Europe, at present live only in Africa. Of the families living in America, the broad-nosed monkeys (*Platyrrhines*) alone belong exclusively to the miocene of that country; while the Madagascar urchin may, perhaps, be found already in the miocene of Europe.

What light, now, do these facts throw upon the migrations during the geological epochs? In answering this question, I omit the upper tertiary strata; the pliocene, because, to use that expression, this epoch is not important as a period of creation. It has developed no new types, and serves merely as an intermediate link between the miocene and the present time.

The *monkeys* show no migrations from one hemisphere to the other. Broad noses and small noses have remained since their origination in their respective parts of the globe. The monkeys of the miocene strata of Pikermi in Greece, and Sansans in France, may have possibly migrated toward the south to the tropical regions of Africa; the *Dryopithecus* of Sansans seems, at least, to be closely related to the gorilla and chimpanzee, and may be considered their ancestor, and the great monkey of the Sivalik Hills might have the same relation to the orang-outang.

Exactly the same observation we have to make of the *half-monkeys*. The genera oscillating between these and the hoofed animals are limited to their respective hemispheres, but the *Necrolemur* of Quercy may have migrated to old Celebes, and there may have become a potto; but the animals resembling the half-monkeys disappear from the American scene with the eocene period—no genuine half-monkey has migrated.

The *bats* are found in strata of equal age on both sides of the ocean; they can, therefore, throw no light upon the question.

Among the *rodents*, the squirrels, rell-mice, and mice are found in the eocene period of both hemispheres; those types, therefore, may have developed independently in both parts of the globe.

The insectivorous animals, together with the moles, appear in the eocene, and, together with the urchins, in miocene. A migration of them along the degrees of latitude can, therefore, not be accepted, although it may be that the tenrecs (*Tupajida*) migrated in a longitudinal direction toward India.

The *rapacious animals*, which during the eocene period are still very slightly differentiated and show no distinct family characteristics, have during that period no genus common to both hemispheres. The case is different during the miocene period. The dogs and cats, as well as the hyenodonts, which have since become extinct, show several genera common to both divisions of the globe, such as *Machairodus*, *Hyænodon*, *Amphicyon*, *Pseudalurus*, *Canis*, and *Felis*. If we now assume that these rapacious animals have persecuted their prey over both hemispheres, then we should have some sign that these prey-animals have also fled all over the globe. How does it come, then, that the hyenas and civet cats, which during the miocene period are expanded all over the Old World, have not come also over to the New World, where they have remained strangers at all times? How does it happen that the martens, which are so frequently found in the tertiary formations of the Old World and in the present epoch of America, are so very rare in the tertiary epoch of the latter continent? How shall we explain migrations regarding bears, which appear in India already during the miocene period, while in America they are not found until the diluvial formations.

All those facts seem to me a proof that migrations of rapacious animals during the tertiary period are improbable. I believe much more that from the different families of carnivorous animals that existed during the eocene period, and which differentiated so little, our modern rapacious animals, the genera of which are so distinctly separated, have been developed.

The *Perissodactyls* lead to the same conclusion. We have already mentioned the parallel development of the horse series in both hemispheres—indeed, were we to assume that the links of those series, which are in both hemispheres so similar, are the result of migration, the horses of the tertiary period would have had nothing to do but to gallop from one part of the globe to the other!

The *tapirs*, at present, inhabit South America and India. A migration of them in a latitudinal direction cannot be supposed, because there are plenty of original forms in both parts of the globe (at least since the middle eocene period) from which they may have developed. Why cannot the tapir of East India and Sumatra be a descendant of the genera *Lophiodon*, *Tapirulus*, or *Protapirus*, of the Old World, and the tapir of Brazil, and the *Elasmognathus* of Guatemala, descendants of the American genera *Helaletes* and *Hyrachyus*? In both cases the same phenomenon would have been repeated, viz., a migration toward the south.

The same is the case with the last family of the Perissodactyls, viz., the *rhinoceroses*. Marsh supposes that the American genus, *Amynodon*, of the eocene period, is the original form; but the European genus *Aceratherium*, that belongs undoubtedly to the same family, is found already in the phosphorites of Quercy, which are of an equal age, and although the genuine rhinoceroses of America have become extinct with the pliocene period, they still continue to exist in the Old World, but just as the tapirs only in tropical regions.

The perissodactyls, *Coryphodon* and *Chalicotherium*, are common to both parts of the globe. But, as they are found in layers of equal age, and as we know neither their ancestors nor successors, we have no right to assume a migration.

The (even-toed hoofed animals) *Artiodactyls* show, during the eocene and miocene period, distinctly separated groups in both hemispheres, and nowhere can a trace of migration be detected.

The ruminants lead to the same results. Their still less different shaded original forms are, during the tertiary period, so abundant in both parts of the globe, that Gaudry complains of the difficulty in connecting *Gelocus*, *Lophiomeryx*, *Tragulohyus*, and many other intermediate forms as original forms with the families which, later, have become differentiated. We have to say exactly the same of the American genera, *Hyopotamus*, *Eomeryx*, *Homacodon*. Although Marsh sees in the eocene *Parameryx*, the ancestor of the camel, and in the *Oromeryx*, of the same strata, the ancestors of the deer, he pronounces this view only hesitatingly. But however that may be, outspoken family characteristics of the ruminants do not appear before the miocene period in both parts of the globe, and as soon as this differentiation of the types has taken place, all genera and most families are perfectly separated. The dwarf-deer (*Tragulida*), the musk-oxen, the giraffes, and the hollow-horned animals, are, during the miocene period, limited exclusively to the Old World, while the camels and the deer are found in both parts of the globe, but having perfectly different genera. If these two latter families, as Marsh says, have migrated from America to the Old World, how happens it, then, that the dwarf-deer and giraffes have not found the same way, and that the hollow-horned animals have not come to America before the pliocene period? I speak not of the heavy cattle, but of the light-footed animals and goats, herds of which are buried in Pikermi, Sivalik, and Sansans, and the descendants of which still execute great migrations—would not these have been able to follow the deer and camels?

The *trunked-animals* are found, during the miocene period, in the Old World exclusively, and we must assume that this (India), was their birth-place, from where they expanded all over the world, not arriving in America before the pliocene period.

"The *edentates*," says Marsh, "are evidently an American type." I am far from contradicting the truth, which is proved by the modern distribution, by the enormous sloths and armadilloes of the pampas deposits, and by the genus *Moropus* of the middle eocene strata of America. But I maintain that the edentates are also a type of the Old World—the *Ancylotherium* of the phosphorites of Quercy is at last of equal antiquity with the American *Moropus*, and although the macrotheria of Pikermi and Sansans are somewhat younger, they are closely connected with the African ground-hogs, and indicate thus a series of development belonging exclusively to the Old World. Although I do not doubt that the North American edentates have, at the commencement of the pliocene period, migrated to South America. I emphatically deny that a migration of edentates from the New World to the Old World has taken place.

Marsh assumes that this migration was executed over the Behring Strait, which was dry during the miocene period; but even if we would admit that the phosphorites of Quercy are of equal age with the strata of Oregon, where *Moropus* was found (they are older), we would have to assume that the slow, heavy edentates, during the middle miocene period, have migrated over half the globe, from Oregon, crossing the Behring Strait, all over Asia and through Europe to the western coast of France, while at the same time one party of them had deviated to East India and another one to the Cape of Good Hope! Is this probable? Is it possible?

This would, perhaps, be sufficient. But the works of Heer and other botanists show that during the miocene period there existed in the polar countries—Spitzbergen, Greenland, and Grinnelsland—a vegetation indicating the present climate of Southern California or Texas. The climate, therefore, could not have hindered the animals from living during that time on both sides of the Behring Strait, provided that that strait was dry. But what do we find in reality? A perfect separation of types with a few exceptions, which are easily explained if we assume that these common types (rapacious animals and perissodactyls), have descended from independent origins in the same direction by a parallel development.

I am, in this regard, perfectly opposed to the opinion held by Mr. Marsh. What he explains to be the result of migrations I consider as the result of a parallel development and final convergence of the descended types which he himself has so beautifully illustrated in his works concerning the tooth-bearing birds of the cretaceous period. As to my opinion, the several orders have, in the course of their development, very often become convergent toward each other, and finally produced forms which are very closely related or even identical to one another, although they have originated from separated roots.

But maintaining that the two hemispheres have been perfectly separated during the eocene and miocene periods, I am very far from denying that extended migrations have taken place during that time upon either of these hemispheres. The elephants, hippopotami, and many other forms, seem to have migrated in similar manner from East India to the other parts of the Old World, as the edentates and llamas have migrated from North America to South America. But even these migrations we only assume, because we know no hypothesis which offers a better explanation. If, for example, in Africa miocene hippopotami were to be discovered, the hypothesis of even the migrations would have no longer any basis.

Returning now to the facts which have been as yet discovered, we believe we have a good reason for the assumption that all intercourse between the faunas of both hemispheres has taken place during the pliocene and post-pliocene periods.

The trunked animals seem to indicate a migration which took place during the commencement of the pliocene period. As Lyell and Crag have shown, the cold progressed slowly and gradually during the pliocene period. Now, all animals which are at present common to North America and Europe, are such as show by their bodily constitution power of adaptation to colder climes. All these types (as bear (grizzly), buffalo, aurochs, reindeer, fen wolf, marten, etc.), are, it is true, somewhat differentiated, but, nevertheless, they are in both hemispheres so similar that the naturalists are often at doubt whether to call these types varieties or different species. Mastodons and elephants which, in America, still existed during the diluvial period, have evidently been protected against the cold, as the "mammoth" of the old continent, which progressed as far as Alaska.

During the geological period preceding our modern epochs, on both sides of America there must have been broad land ways leading to the neighboring continents, over the Behring Strait to Siberia; over Iceland, Shetland, and the Faröe Islands, to Europe. Upon this last way, which is chosen even at the present period by our birds, the musk-oxen have perhaps withdrawn. This peculiar animal offers, perhaps, one of the most beautiful specimens of transmigrations from one continent upon the other. During the ice-period this animal existed all over Northern Europe and Asia; to-day it inhabits exclusively the American Polar regions. It, therefore, must have emigrated, for the climate at the shores of the Obi and Lena rivers was certainly not the reason for its extinction.

Having arrived at this point, we may sum up our views in saying that as regards the present distribution of land-mammals, our fauna consists of four different regions, which were separated from each other at different periods:

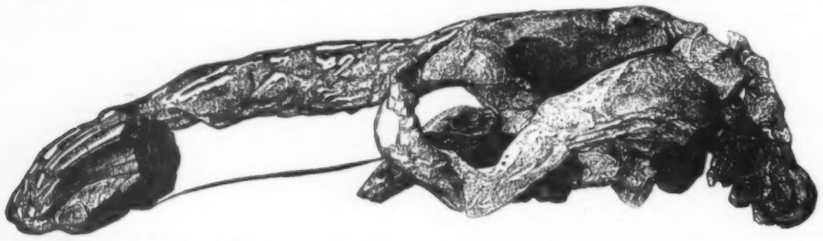
The *Australian Region*, which became independent at a very early period, and has been separated from the other continents *at least* since the commencement of the tertiary period, and without doubt already before the appearance of the placental mammals; the *Region of Madagascar*, which remained isolated since the period of the lower eocene strata, and *after* the appearance of the first placental mammals; and finally, the regions of the *Old World* and of the *New World*, which were separated *during* the eocene and miocene periods, but were connected later during the pliocene and post-pliocene periods, by stretches of land over which migrations could take place. During the eocene and miocene periods, therefore, the animals' migrations were limited, in a similar manner as at present, by the existence of two oceans, and could only take place upon the surface of the continents chiefly in the direction of the meridians.

DISCOVERY OF THE ENTIRE SKELETON OF RYTIODUS.

THE remains of the *Sirenian*, on which Lartet erected his genus *Rytiodus*, consisted only of two pairs of incisors, which were found by M. Capgrand, in 1864, in the quarry of Bournic, near Sos (Lot-et-Garonne), France. It was not till 1866 that the finder sent these teeth to M. Lartet, who, in June of the same year, made a communication on the subject of them to the Geological Society of France. From that time to the present no other remains of the animal have been discovered. In considering these teeth as certainly belonging to a new genus, allied to *Halitherium*, Lartet gave still another evidence of that acuteness of judgment for which he had always been distinguished, for now the discovery of almost an entire skeleton goes to entirely confirm the eminent paleontologist's opinion. The accidental finding of these bones of *Rytiodus Capgrandi* occurred as follows:

In September, 1861, three years after M. Capgrand's discovery, a M. Boudin, owner of the domain of Plantat, in the canton of Labrède (Gironde), was having some land graded, when the workmen uncovered, at a depth of about five feet, in the shell marl, a complete skeleton about sixteen feet in length. Curious to know what sort of a beast they had come upon, they carefully removed the soil, whereupon they had the animal before them in its entirety. As often happens in cases of this kind, however, their curiosity led them to detach the skull from the other bones, and to break it apart with their picks. After each man had had his say about the matter, they gathered the bones up by the shovelful, threw them into the wheelbarrow, and dumped them into a spot that they were filling in, at two or three hundred feet

distant. The curiosity of one of the laborers being awakened by the size and form of the teeth, he was led to carry home a portion of the premaxillary, with the adhering portion of the incisors and a fragment of the superior maxillary, with the first two molars in place. These valuable *débris*, after lying dust-covered on the mantelpiece at his cottage for two years, found their way by chance into the hands of M. Braquehaye, director of the Municipal School of Design at Bordeaux, who, suspecting their importance, put them into the hands of M. E. Delfortrie. Their origin having been traced, the locality was visited, and after some search nearly the entire skeleton was recovered. The *Rytiodus*, as Lartet had truly suspected, constitutes a new genus of the Sirenia, allied, as before stated, to *Halitherium*. Like the latter, it is related at once to the sea-cow (Manati) and the dugong, but in different directions. Thus, while *Halitherium* is related to the dugong in the general form of the skull and the number of molars, and to the manati in the mastodontoid shape of the molars, the *Rytiodus* is allied to the dugong in the incisors, and in the number of molars, and to the manati in the general form of the skull and that of the molars. The curious animal under consideration, then, is, indeed, as Lartet well said, a sub-genus of Halitherium. The fossil was found at precisely the same horizon as the specimen discovered by M. Capgrand, although the localities were remote.

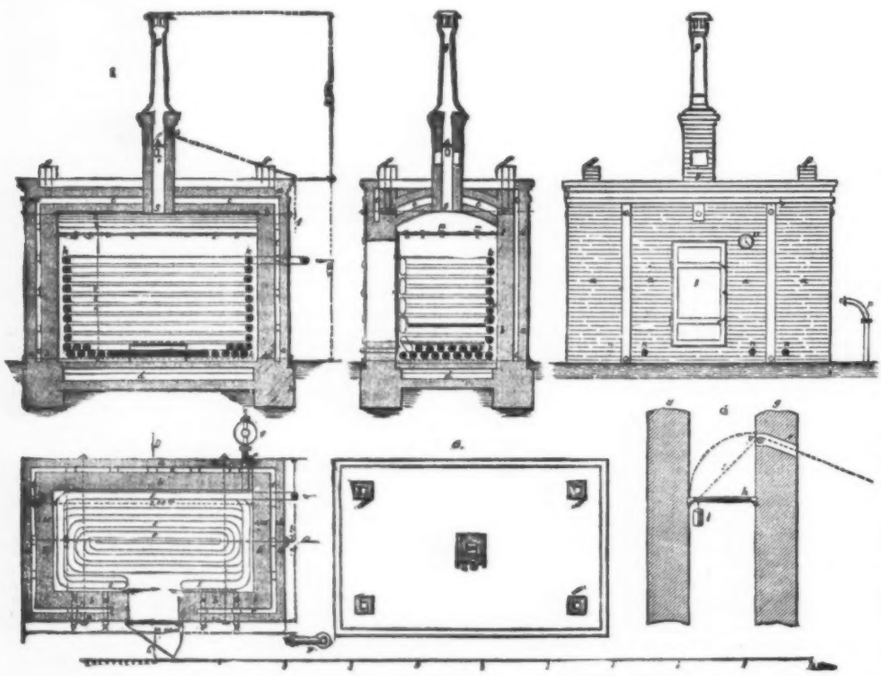


FOSSIL SEA COW (*Rytiodus Capgrandi*).—Profile View of Skull, 1 5 Nat. Size.

APPARATUS FOR HOSPITAL DISINFECTION.

THE arrangements described below for the disinfection of clothing, linen, and other effects of a hospital, has proved to be excellent during different epidemic diseases, and Dr. Werner, of Moabit, has demonstrated experimentally the correctness of the principle upon which these arrangements are based, viz., the destruction of the infecting organisms by a dry heat of (125° C.) 257° F

Virchow's *Archiv* says about it the following: The arrangements consist of double walls, the interval being filled with shavings, which constitute the so-called isolating layer. This latter is not only between the side walls, but also between the walls of the ceiling and of the floor, and is connected at the four corners of the building with pipes which permit the evaporation of the moisture that is absorbed by them in great quantities. In the walls of the ceiling is a chimney which can be closed by a flap, and which connects the disinfection room with the atmosphere outside. The room itself is furnished with a system of iron steam pipes, by which the heating is effected. The steam does not enter the disinfection room, but is collected in a condensing vessel outside. The steam has a downward direction, entering a pipe which is 9 feet above the floor, and escapes through a pipe which is on a level with the floor; and these pipes are so arranged that they can be easily cleaned, as can the walls also which are beside them and beneath them. The room has a door (Fig. 3) which can be tightly screwed, and which is furnished on the outside with a pyrometer which gives the inside temperature. This temperature must be raised to 257° F., as above-mentioned, in order to obtain a perfect destruction of the microphytes. The brick-work which forms the floor is inclined, the lowest part being connected with a canal which serves to carry off the water used for the process of disinfection, this water having been admitted through a bent pipe (Fig. 3 *p*), to which a hose may be attached. On each side of the door may be seen the mouth-openings of air-pipes, which can be closed with tin covers, and which serve in connection with the chimney for the ventilation of the room. Above the first layer of pipes is a floor consisting of boards of wood which can be removed when it requires cleansing. The objects to be disinfected are hung up on the hooks of the traverse rods with which the room is provided. The cost of these arrangements, by which all the objects belonging to a hospital having about a thousand beds can be cleansed in 24 hours amounted to $508.75. The inventor believes that transportable arrangements built upon the same principle can be easily constructed, and draws the attention of our technical students to this fact.



APPARATUS FOR HOSPITAL DISINFECTION.

NASAL CATARRH.

By DR. F. H. BOSWORTH.

AT a recent meeting of the New York Academy of Medicine, the author said that he had designedly chosen as his subject for the paper this evening some of the unsettled questions in connection with nasal catarrh, in order to bring forward some of the conclusions on the subject which he had arrived at as the result of his experience, and to bring out discussion which might lead to a clearing up of some of the dark points. The main points were: 1. What was nasal catarrh? 2. What were its tendencies? 3. How could it best be treated? and 4. Could it be cured?

In the first place, as to the nature of the disease, in glancing over the literature of the subject one would find a great multitude of names; but there was really only one disease, and this was nasal catarrh. Dr. Bosworth preferred to retain this name, not only because it was old and generally accepted, but also because, after all, it best described the disease. As to the region which was affected, looking at a plate of the mouth, nose, and pharynx, it would be noticed that the soft palate divided these, taken as one, into two parts, differing much in their physiological relations; the lower of these was constantly swept by the fluids and solids taken into the stomach as food and drink, and there is no chance for the natural secretion of the part or of foreign bodies to collect. The upper cavity, on the other hand, took part only in the function of the respiratory system and was swept only by the air; it was covered with a mucous membrane richly endowed with glands which poured forth an abundant secretion, at the same time that, in the course of its organic activity, the epithelium was being desquamated with greater or less rapidity, the only natural method for the removal of the effete material thus collected was by the movements of the cilia. The lower region was kept clear, while in the upper the mucus and epithelium remained, especially if the epithelium was destroyed by an inflammatory process. According to anatomy, the nasal cavity extended from the anterior to the posterior nares, while the pharynx extended from the posterior nares to the larynx; but according to their physiological functions, the dividing line was the uvula, and, therefore, the nasal cavity included what was known as the pharyngeal tonsil. Nasal catarrh was the inflammation of that part of the mucous membrane of the respiratory tract above the uvula.

Secondly, as to the morbid process constituting the disease, the mucous membrane was composed of three layers: first, a basement membrane; secondly, connective tissue, glands, and blood vessels; thirdly, an upper layer of epithelium. In the process of inflammation there first occurred an increased determination of blood, followed by an exudation of white blood globules, together with some of the other constituents of the blood. By the increased supply of blood the glands were stimulated to an enormous exaggeration of the natural process, leading to an increased secretion and desquamation of the epithelium. This was what occurred in an acute inflammation. In a chronic inflammation the pathological process was similar, the only difference being that the blood vessels were not so engorged; but there were the same cell proliferation, increased discharge, desquamation of the epithelium, etc. As this process continued, there was a genuine hyperplasia, and the whole membrane became thickened and hypertrophied, while the glands were all the time pouring out their secretions. If the secreting organs underwent hypertrophy at the same time that the membrane was thickened, there was an increased discharge, constituting one form of the disease, and that by far the most frequently met with; but if though the hypertrophy of the connective tissue the glandular structure was encroached upon, the glands atrophied and a dry catarrh was the result. Hence, there were two varieties of chronic nasal catarrh; in the first and most common there was hypertrophy with increased secretion gravitated back into the pharynx, and gave rise to the hawking in order to loosen and expel it. There could be no doubt that by far the greater part of the secretion arose from the nasal passages and not from the pharynx. At the same time the breathing space was narrowed, producing a sense of discomfort, and compelling the patient to breathe through his mouth, leading to inflammation of the pharynx and larynx. If the air, before reaching the throat, had to pass through the nose, it was warmed and cleansed, and thus rendered unirritating; but if passed only through the mouth, this effect was not produced and it became a source of irritation. This explained how it was that patients complained more of the throat than of the nose in this disease, though it was in the latter the principal trouble lay.

In the second variety, the essential pathology was similar to that of the first, consisting of a deposit, in the meshes of the cells of the mucous membrane, of new cells and fibers; but by these the glands were encroached upon and a thick secretion was poured out, drying as it formed, so that a thick pellicle was produced which was dry but formed a protection to the surface. Under this the secretion continued to be poured out, but as it was not exposed to the air it did not dry, but remained and decomposed, giving rise to a purulent discharge. In this way the pellicle was lifted up and removed, leading to the discharge of those offensive masses which formed such a disagreeable feature of this form of the disease. Ulceration in the nasal cavity, said Dr. Bosworth, was not a symptom of nasal catarrh; he had never seen it except in syphilitic or scrofulous patients. The hypertrophic form of the disease was that which presented itself in the great majority of cases.

The next question was, What were the causes of chronic nasal catarrh? And the first thing to be settled in answer to this was, was there a catarrhal diathesis? The thought that the introduction into medical ætiology of a scrofulous diathesis, a syphilitic diathesis, a cancerous diathesis, a hemorrhage diathesis, etc., had already done mischief enough, without adding to the already long list a catarrhal diathesis. It occurred in all ages, in both sexes, in all conditions of life; men were more frequently attacked than women simply because, by the nature of their occupations, they were more exposed to the exciting causes. It occurred in patients otherwise in perfect health. The air irritated the membrane of the nose and caused a mild chronic inflammation; the patient caught cold repeatedly, the condition was aggravated, until finally a chronic catarrh was produced. It might result from measles or from any disease one of the features of which was a coryza. It was essentially a disease of those climates in which the air was subject to rapid changes of temperature and humidity.

What were the tendencies of the disease? In the first place, to cause inflammation of the larynx and pharynx. These patients were particularly liable to catch cold; that is there already existed a mild chronic inflammation, as stated above. As these attacks recurred, there was a tendency toward the lungs, the pharynx being first attacked, then the larynx, then the trachea, and finally the bronchi; causing successively pharyngitis, laryngitis, tracheitis, and bronchitis; nasal catarrh was therefore a constant menace. The question was frequently asked, whether the disease would extend to the lungs. In view of the fact that this was a not improbable danger, a negative answer should not, in all cases, be given.

The third and most important question was as to the treatment. The disease was essentially one of hypertrophy and increased secretion. Relief of one symptom relieved them all. When the nasal douche was first suggested, it was thought that this offered a means by which the disease could be cured; but a long experience had demonstrated the failure of these expectations; only a relief could be obtained. The fluid only traversed the air passages slowly and did not mount higher than the middle passage; and therefore it did not even thoroughly cleanse. Nearly thirty years ago atomization of the fluids as a means of medication was introduced, and the same hopes were raised; it enabled us to make applications in such a way that every part was reached; morbid activity was to a certain extent controlled, and if the disease was mild it might be arrested; but in the more aggravated cases there was no permanent cure, but the disease returned in an aggravated form. He would not enter on the discussion of the use of powders: the same remarks applied to them as to the atomizers. As these means failed, the final alternative arose of resorting to some destructive agent; and the opinion was growing that this was the only method. This was the result which Dr. Bosworth had arrived at as the result of a considerable experience both in private and in hospital and dispensary practice. First, as to direct means, as by Beverly Robinson's forceps: the instruments tore and bruised, and the method was, moreover, a bloody one. Next, as to chemical agents: few were of greater value than the nitrate of silver, and few were more abused; it was an escharotic, but it was also a stimulant; hence, while it cauterized above it stimulated to increased activity the parts below. He rarely made use of a stronger solution than one of the strength of twenty grains to the ounce. To nitric acid there was not the same objection that there was to nitrate of silver, but its action could not be controlled. To overcome this objection the device of Dr Andrew H. Smith was efficient; it consisted of a glass tube

with a fenestra, and was put into the nose so that the hypertrophied mucous membrance to be cauterized protruded through the fenestra into the tube, a probe with a pledget of flint wrapped around it and moistened with nitric acid was then introduced and touched the protruding membrane. Chromic acid in the form of acicular crystals was, perhaps, better than nitric acid; but Dr. Bosworth's experience in its use was so limited that he could not state any positive conclusion on that subject. But the best of all escharotics for this purpose was glacial acetic acid; it not only destroyed the hypertrophied membrane, but by its absorptive influence it acted well on the deeper parts. At first it caused some swelling, but this soon subsided. It was applied by a narrow bent probe, which was wrapped in lint, and one side of which was moistened with the glacial acetic acid applied to it with another similar probe. As the application was painful, it should be immediately followed by the use in the atomizer of Dobell's solution, the formula of which was:

℞. Carbolic acid	gr. j.
Soda,	
Borax	aa. gr. ij.
Glycerine	ʒ i.
Aquæ	ʒ j.

At first the application should be made frequently, afterward less often, the patient should not be allowed to leave the office till all irritation has subsided. In Dr. Bosworth's hands the results of this method had been positive. When the means before described were not powerful enough, the galvano cautery might be used; but it was cumbrous, expensive, and troublesome. Dr. Bosworth showed an instrument for this purpose which Mr. Ford had made for him, in which the current could be closed or opened at will. The result was a cicatrix which subsequently contracted. The septum was protected by an instrument devised by Shirley. In applications to the vault of the palate, in order to avoid injuring the soft palate, the latter might be tied up, as described at a former meeting of the Academy, or, if this was disagreeable, an instrument shown could be used by which it was protected by a hood. In many cases of nasal catarrh there was a large mass of sessile material which almost occluded the nares. The best method of removing them was by an instrument devised by Dr Jarvis, Dr. Bosworth's assistant, which was a simple ecraseur, and by means of which he had often cut through dense fibrous masses; of course there was considerable hemorrhage, but if the operation was done slowly, the hemorrhage was slight and might easily be controlled by a pledget of absorbent cotton. The same thing might be in front and could be removed by a transfixion needle. He had confined his remarks to the nasal cavity to the exclusion of the pharynx; but the latter he regarded as a part of the nasal cavity, its vault was supplied with numerous glands, for which reason it had been called the nasal tonsil. This part had not much to do with it, but the cautery was the best cure. He used the carbolized alkaline fluid, already described, first, followed by an astringent lotion; but these were only preparatory measures. Which of the measures described was to be used in a given case? If there was a mass of hard material at the anterior or posterior nares as described, it was to be removed with the ecraseur or the transfixion needle. When the lower and middle turbinated bones were deeply involved the actual cautery should be employed; if the case was mild, acetic acid should be used. He should mention one of the dangers to which all these forms of cautery were liable; this was facial erysipelas. This might happen with an ordinary coryza, and as this was caused by the application of an escharotic, the liability was increased. The galvano-cautery was the most liable to be followed by this accident, then nitric acid; Dr. Bosworth had never seen it occur after the use of acetic acid.

Lastly, the question arose, Could nasal catarrh be cured? No physician could promise a cure for any case in which the disease was one long established. A special case might be cured, but no one could cure all. The physician, therefore, should not promise; but if he used all the means of diagnosis and treatment now at our command, he might cure many. Hence, with our present knowledge we could remove all the symptoms of discomfort and all the dangers to other parts.

As to the means of diagnosis, Dr. Bosworth thought that the best method of examining was by the aid of sunlight in connection with a head light. Tobold's apparatus was very unsatisfactory. The laryngoscope had brought in the use of the spray and douche; but he thought that although we might not have to lay them aside altogether, still they would have to be modified.

Discussion being in order, Dr. Douglass was called upon, and said that he had been very much pleased with and interested in this paper which had just been read, but he must take issue with the author on one or two points. He would come at once to the consideration of the treatment; but first, as to the cause, he wished to say that he did consider nasal catarrh a constitutional and not a local affection. A simple catarrh or ordinary cold in the head had at first constitutional symptoms: chill and fever; then the symptoms of the catarrh, hypertrophy, and stenosis. What was seen in acute catarrh was also met with in chronic, the latter being merely the result of repeated attacks of the former. After a time the hypertrophy was diminished; then there was a discharge of the thick masses so well described by the author of the paper. Then, besides, the other secretions were affected; in every case Dr. Douglass examined the urine and found a diminution in these salts excreted; the liver also was affected. Hence constitutional remedies should be brought in with the local; and by the use of both together, the disease could be cured. The hypertrophy was very easily relieved by quieting the sensitiveness of the parts: first cleansing with the nasal douche, then injecting laudanum varying in strength according to circumstances from one to eight to pure, and he found the irritation almost immediately relieved. He then addressed the constitutional disturbance. In chronic catarrh, where there was atrophy of the membrane and the glands, he stimulated the parts by the application of a mild stimulant such as heat. He used the anterior and posterior nasal douche, and he could see whether the parts were free from mucosities or not. He then used an emollient. Just as the gynecologist used heat as a stimulant to the uterus, so he used heat to stimulate the mucous membrane of the nose. This method, he was aware, took a long time, but there was no destruction of the glands which were necessary in order to supply mucus. He then applied some bland remedy such as vaseline or carbolized vaseline. His own view was that the liver was the seat of most of the trouble; when the salts which should be excreted by the liver were not so removed, if they did not find an exit in the skin or other organ, they would elsewhere, as in the nasal passages. Many had an attack of jaundice while under treatment for nasal catarrh, and when they recovered from the former they were also free from the latter. Hence he would take issue with the author of the paper as to the constitutional nature of the disease.

Dr. Andrew H. Smith, being called upon, said that, like the giver of a certain feast, the author of the paper had left his best wine to the last; and that was the part in which he recognized the inherent difficulties of the subject. Every writer on the subject had his favorite remedy, and one would conclude from reading their works that almost any plan of treatment would be certain to effect a cure; he would fail to find a candid recognition of the difficulties. But the more a man knew on the subject the less confidence would he have in his ability to treat all cases well; he believed all could be relieved, but the bad cases could not be cured. There were many difficulties in the way; one was, that the original cause could not be removed; inheritance, diathesis, climate, were conditions which could not be changed, and where the physician was called upon to effect a cure, he was asked to give the patients not only all they had before but more. There was also the difficulty of reaching the parts, and he agreed with the author as to the difficulty of reaching all parts even with the spray. The particles when projected adhered to the surface upon which they first impinged, and this received the greater share. This difficulty was perhaps not so great in the case of powders, as, though the particles at first adhered to the parts first struck, still there was soon a dry surface produced from which the next particles of the powder would rebound so that all the surfaces could be reached. Douches could be best introduced from behind, and if injected forcibly nearly all parts would be reached. Dr. Bosworth had spoken of chemical destructive agents, and Dr. Smith agreed with him as to their usefulness. He had lately used chromic acid in the form of the strongest solution, made by dropping a little water on the creptats; it immediately destroyed the sentient nerves, and this, he thought, gave it an advantage over acetic acid. He thought the use of stimulants advantageous, as Dr. Douglass had said, and for this purpose he preferred nitrate of silver in powder. For this purpose he had mixed it with subnitrate of bismuth, but this mixture became lumpy, and in order to mechanically separate the particles he had added sulphate of potash in the following proportions:

℞. Potass. sulphat	ʒ j.
Bismuth subnit	ʒ i.
Argent. nitrat	gr. x—xl.

This he found, formed a powder which was permanent, and could be readily blown into the nasal cavity. Its action was permanent, though mild, and he had found it most satisfactory, especially for dispensary use. One of the greatest difficulties in the way of a permanent cure was that finally a stage in the course of the disease was reached in which it was less troublesome than the treatment, and the patient discontinued his visits. The most healthy membrane, if constantly subjected to a foreign body, would have a diseased condition produced; so that, if we had a specific agent, the time would come when it would cease to be curative but would become irritating. He agreed with Dr. Douglass as to the constitutional symptoms. He wished to remark that his instrument, which had been kindly mentioned by Dr. Bosworth, was not made of glass but of hard rubber.

Dr. Morris J. Asch being called upon, said that he thought the subject had been so thoroughly discussed that he could only repeat what had already been said. He agreed with Dr. Bosworth as to the hypertrophy of the membrane and the enlargement of the turbinated bone which occurred in bad cases, but in many cases there was neither; here the lesion was situated on the posterior surface of the velum. These cases were characterized by a morning cough which might go on to the production of vomiting. He thought that the cause in many cases was constitutional, and in all cases the best results would be attained by attending to the constitutional as well as the local condition, and more especially attending to the skin and kidneys; as regards the liver, he had never had his attention called to its possible connection with the trouble. He used Dobell's solution to cleanse the parts first, as all applications were useless unless the parts were first cleansed. He used nitrate of silver in solution of the strength of twenty to forty grains to the ounce, and he could apply it in almost all cases, introducing it on a sponge behind the velum, or on an aluminum probe passed through from in front. When there was hypertrophy, he thought the galvano-cautery was the best means of removal, as the offending membrane was gotten rid of as well as by the ecraseur, and there was no interference with the olfactory.

Dr. H. Knapp, being called upon, said that he had seen many cases of nasal catarrh occurring in children who were at the same time suffering from diseases of the ear. He regarded the subject as analogous to conjunctivitis, and the treatment of nasal catarrh was going through the same stages as had occurred in the history of the treatment of conjunctivitis. There had been a time when in the treatment of this disease escharotics, cauterants, and mechanical means were employed; but now oculists only applied such remedies as stimulated and produced absorption, and thus obstinate cases could be cured, which could not be done by caustics. In naso-pharyngeal catarrh there was hypertrophy, but this was not to be treated by the cautery; a one or two per cent. solution, injected with the posterior nasal syringe, reached all parts, even the frontal sinuses. In children, where there was hypertrophy filling the nasal cavity, the use of the posterior nasal syringe with a mild solution, persisted in for months, effected a cure; but he had treated them by analogy to similar conditions occurring in the eye. As to the constitutional origin of the disease, a similar analogy existed; the glaucomatous diathesis was admitted; but all fell into the local disease and its effect on the organism.

Dr. Bosworth, in closing, said that he wished to elicit discussion as to the possibility of a radical cure. He recalled many patients who for a long time came to see him regularly, with a perseverance which was admirable, and who yet grew worse if they stayed away for any length of time. He had sought for constitutional symptoms, but had failed to find them; there were no indications of syphilis or scrofula unless there were mucous patches or strumous ulcers. His treatment was not rude, rough, or brutal, and did not produce any great amount of irritation. As to change of climate, it did good for the time being, because the effect of climate was felt in the mucous membranes, but as soon as the patient returned, the old trouble came back.

Dr. Chadsey said that he had early met with nasal catarrh in the course of his practice. The first question was, What produced it? There was first a sudden cold which led to obstruction of the small vessels which carried off the effete material. Fifty years ago the first remedy was sweating, and hot vapor was inhaled. He had come to the conclusion that we must use some internal remedy which could pass through the smallest blood vessels and overcome this obstruction. All diseases, as taught by Prof. Batcheler, of Springfield, arose from the obstruction of the small vessels, and the remedy which could overcome this was mercury; hence such a cold was treated with perspiration and a mild preparation of ipecac and calomel. He had a patient who had come to this city and put himself under the treatment of Dr. Noah Green, and had died from the effects of the nitrate of silver which the latter had employed. He had sent a patient to the seashore who suffered from nasal catarrh at Saratoga, and who was free from it in the moist air of the ocean and in the dry, pure air of the mountains. The reason why he gave mercury was to overcome the obstruction in the capillary vessels; he had had the best success with it, and he was sorry that the profession was so prejudiced against the drug.

Dr. O'Sullivan said that he was called to his feet by the reference of Dr. Chadsey to Dr. Green, the Nestor of the profession, who had made the specialty and first used the most effective of all remedies. He had been a student of Green's, and if he could lay claim to any remedy, he had found nitrate of silver best.

Dr. Douglass said that he was very familiar with Dr. Green's methods of treatment, and he knew that Dr. Green's applications to the posterior nares were of the mildest character.—*Medical Gazette.*

THE PROGRESS OF SURGERY IN THE NINETEENTH CENTURY.

SURGERY has outranked all other branches of medicine. Practical observation its basis. Aided by the development of natural sciences. The knowledge of inflammations extended. Virchow's doctrine of the thrombosis (closing of blood vessels) and embolism (wandering of pathological products). Humane tendency of modern surgery. Horace Wells the first to use anæsthetics. Cheated by two Boston colleagues. The three pioneers in the use of anæsthetical means, end by suicide, misery, and insanity. Open treatment of wounds introduced by Kern, Vienna. Excluding of atmospheric air. Langenbeck's method. Liston's antiseptic treatment. Atomizer used for producing a spray of carbolic acid. Cleanliness in operations. Esmarch in Kiel introduces a method for producing artificial bloodlessness. A new era of humanity. Merits of Demarquay in France and McCormac in England, and is at present employed all over the world.

Improvements in special branches. Underbinding of blood-vessels. Red hot irons out of use. Skillful cure of deformities. No amputations necessary. Simple orthopædic treatment and tenotomy. Merits of Delpech, 1816, and Strohmeyer, 1831. Plastic operations. Carl Ferdinand Graefe (died 1840) and rhinoplastic operations. Successful operations of the vesico-vaginal fistulæ, a great blessing to humanity. Great success of the French in this direction; Jobert de Lamballe's method. The improvements of Gustav Simon. Great merits of the Americans in gynecological operations. The successful operations of Marion Sims.

First ovariotomy by Robert Houston, 1801. The first great number of them executed by the American, McDowell; the Italian surgeon, Emiliani, in Faenza. Koberle's merits. 1870 already 2,187 ovariotomies executed. Extirpation of the spleen unsuccessfully attempted by Küchler in Darmstadt. Success of Péan in France. Simon in Heidelberg succeeds in removing a kidney, and Sauter, in Constance, first dares to extirpate a whole womb. Trepanations have become less frequent and are only attempted in extreme cases. Lithotomy makes place to lithotrity. Civiale, 1820, the first pioneer. Causes of the death of Napoleon III. Tracheotomy, already executed by Asclepiades, becomes more frequent in cases of croup and diphtheria. Carl Heinrich Ehrmann makes the first laryngotomy. Perfect extirpation of larynx by Prof. Billroth, Vienna. The French surgeon, Chassaignac, 1858, invents the écrasement linéaire; unpopular at present. Galvano-caustic operations introduced. Galvano-puncture and electrolysis. Petréquin, Lyons (died 1870), makes improvements in cases of aneurisms. The Italian Scarpa, Monteggia, preposes alcoholic injections. Pravaz, a renowned surgeon of Lyons, invents the hypodermic syringe. Larry, the surgeon of Napoleon I., successful in resection of joints. Caries cured by resection of bones.

CREMATION IN ITALY.

IT is not my intention to write the history of cremation, or to quote its having been extensively employed in former times as an argument in favor of its being adopted at the present day, nor have I any idea of mentioning the various objections brought against incineration of the human body as looked upon from a sentimental or religious point of view.

It must, however, be admitted by most persons that this expeditious manner of disposing of the dead offers great advantages in a hygienic point of view, as compared with the present method of burial, which, in many instances, renders the cemetery a focus of infection.

In the present instance I propose to give a description of the crematories recently used at Milan, and particularly those of Gorini and of Roma-Venini, both having been tested by the Hygienic Congress at the Cimitero Monumentale of that city on September 12, 1880, and where, through the kindness of Dr. Gaetano Pini, I was enabled to be present.

In Italy, and especially at Milan, strenuous efforts have been made to forward the cause of cremation, while crematories will soon be established at Rome, Padua, Udine, and Varese, and it is more than probable that many other cities of the Italian peninsula will do the same.

Ferdinando Coletti was the first in Italy to propose in 1857 cremation as being the most expeditious, most hygienic, and most advantageous plan of disposing of the dead.

The first cremation in Italy in modern times took place at Florence on December 1, 1870, when the body of an Indian prince was incinerated, to effect which seven hours were employed.

Notwithstanding the primitive manner in which the body of the Indian prince was reduced to ashes, the attention of the public and the press was called to a comparatively inexpensive and expeditious plan of destroying dead bodies which for many centuries had fallen into disuse.

Two cremations took place in 1874 at Dresden according to a plan proposed by Siemens. This crematory may be described as consisting of two distinct parts—the heater, which serves as a vestibule to the chamber of cremation, a large flue constructed of fire bricks, between which numerous spaces exist, and the cremating oven capable of containing the body.

The flame traverses the bricks mentioned above, and

passes through the spaces existing between the same, after which it enters the oven, which soon becomes red hot.

The body is now placed in the oven, and a current of hot atmospheric air, made to pass over the hot incandescent bricks, furnishes the oxygen necessary to promote combustion, and incineration takes place in a very short time. This crematory is powerful, and has given good results.

On January 22, 1876, the body of Albert Keller was reduced to ashes at Milan in a crematory invented by Poli & Clericetti. This crematory was heated by ordinary gas made on the spot, and passed, by means of tubes, into the oven. Two hundred and eighty-five jets were used, of which one hundred and eighty were situated at the lower part of the oven, one hundred were placed along the sides, while five large jets were directed against the head, thorax, and pelvis, acting like blowpipes.

Several cremations took place in this crematory, but it was found to be too costly, and it is not used at the present day.

In 1877 the Betti and Ferruzzi crematory was used at Milan. This apparatus consisted of a cylinder of cast iron, placed in the center of a large furnace, heated by means of coke. Into the lower part of this cylinder two long tubes were inserted, destined to convey the products resulting from the distillation of the body into the center of the furnace, where they became mixed with the flame, and served to increase its intensity, thus promoting the cremation. The incineration by this system occupied not less than three hours, and when the distillation had ceased air was allowed to enter the cylinder in order to complete the process.

The final result obtained with this crematory was satisfactory, but from the time necessary to render the apparatus red-hot to completion of the operation, five hours were consumed, at a cost of about twenty francs.

Not being rapid nor economical, this crematory was abandoned.

In the year 1876, on the same day that the body of Keller was burnt at Milan, two hundred persons, belonging to all classes of society, signed an agreement to establish a Cremation Society in that city, since which time seventy incinerations have taken place at Milan, and at Lodi, from 1876 to 1880, fifteen bodies were reduced to ashes, making a sum total of eighty-five bodies.

The two crematories at present in operation at the Cimitero Monumentale at Milan, and which were recently tested by the Hygienic Society, are those of Gorini and Venini.

The object of Gorini has been to obtain, by means of a large furnace, a long flame in which oxygen predominates; this, passing into the oven, surrounds the body in all directions, facilitated in doing so by the form of the chamber where cremation takes place. Another furnace, much smaller than the one mentioned above, exists below the oven, which must be kept in an active state during the entire period incineration lasts. This small furnace serves to produce a current of air, while it at the same time purifies any organic substances carried off from the body by the flame and smoke.

At the side of the crematory small glass windows exist, through which the process of combustion, as well as of incineration, may be observed.

The body having been placed in the oven in a horizontal position, the small furnace is first lighted.

At the expiration of about ten minutes wood is kindled in the large furnace, which is situated three feet below the chamber of cremation, while a grate admits of regulating the supply of air.

The flame, having passed into the oven, envelops the body, while the temperature is raised to 700° Centigrade; it then passes into a canal which leads to the small furnace, where a second combustion takes place, from which it enters the chimney in which a valve exists, by which the ascending current can be regulated.

A body placed in the Gorini Crematory is completely reduced to ashes in the space of one hour and thirty minutes, at a cost, it is stated, of from five to ten francs.

This crematory has been in use for some time. In a recent report regarding cremation, published at Milan, it is stated that, owing to the current of air being very great, pieces of organic matter are liable to be carried from the first chamber to the chimney, and from thence into the atmosphere before they are entirely consumed, impregnating the vapor at its exit with an odor. As regards the quantity of fuel consumed, it must be greater than in the Verini Crematory, to be now described, the grate surface being one meter twenty centimeters square, while the chimney is eight meters high, whereas in the last-mentioned crematory the grate surface is only sixty centimeters square, and the chimney is three meters high.

The most recent crematory erected at Milan is that of Messrs. Poma & Venini, of which I will now endeavor to give a description without the aid of drawings.

This crematory consists of—

A generator, a first oven, second oven or chamber of cremation, and a platform in cast iron, on which the body is placed.

The generator is easily moved; in it is placed the solid fuel, while it furnishes the heated air necessary to produce a powerful flame. In the generator is a chamber lined internally with fire bricks, in which a partial combustion and distillation of the wood used as fuel takes place. At the bottom of this chamber there is a grate, which admits of regulating the supply of air, while at the top are two apertures, one through which the fuel is introduced, and which can be closed by means of a sliding valve, while into the other is inserted a tube, through which the gaseous products pass directly into the chimney.

The vertical slides of the generator are surrounded with a sheet of iron, open below, between which and the sides there exists a small space. The air contained in this space becomes warmed at the expense of the heat thrown off from the sides of the generator.

The first oven contains a refractory tube into which the flame from generator passes, surrounded for a certain distance by another one of iron, into which a certain quantity of atmospheric air enters; this soon attains an elevated temperature.

The second oven, or chamber, in which cremation takes place, is of large size, constructed of firebricks, and provided with a door, through which the body is introduced. The products resulting from the combustion which takes place in the generator pass into the second oven, where they meet with two jets of atmospheric air brought by a pair of tubes, situated on the sides of the crematory, by which a semi-combustion is obtained; they then find their way into two canals situated along the oven, from thence into a large cavity, or chamber; and, finally, pass into the chimney, where a valve is placed, by which the ascending current is regulated.

The platform on which the body reposes is of iron, and can be easily moved in and out of the oven by means of a crank and wheels. The body is raised above the level of the platform about eight inches, on one hundred and twenty iron uprights, covered with fire-clay; the flame can consequently pass freely above, below, and on all sides, by which a rapid and complete incineration is effected.

With the apparatus thus briefly described, cremation is effected in the following manner:

The generator having been withdrawn from the crematory, wood is placed in it and lighted; at the same time a small quantity of wood is kindled at the mouth of the first oven so as to heat it, in order to facilitate the ascension of the products coming from the generator.

At the expiration of about an hour the generator is brought in contact with the first oven by means of tubes, while at the same time, the gas and air valves being opened, an almost colorless flame passes into the crematory.

As soon as the tube leading to the first oven assumes a cherry-red color (about 800° Centigrade), which it does in less than an hour, the body is passed into the second oven, stretched on the platform, already described, the head being placed at the end where the flame enters.

If we now observe the process of incineration by means of the small windows situated at the sides of the crematory, we remark an instantaneous development of vapor, followed by a dense smoke. This smoke is due to the action of the hot gas poured out from the generator, and to radiation of heat from the sides of the cremating oven. The body under the above conditions is soon destroyed, and the gases involved from it fill the chamber, mixing with the products coming from the generator, and are carried off by the canals already mentioned above. Atmospheric air is now allowed to enter, which, mixing with these products, causes a partial combustion which serves to maintain the elevated temperature of the oven.

Before passing out of the chimney, a current of very hot air is directed upon the products of the oven, by which a third combustion takes place, and any organic products that may have escaped from previous burning are consumed before passing into the atmosphere.

If all the valves of the apparatus Poma Venini are in proper position a very light vapor at first issues from the chimney, which ceases in a few minutes, and during the operation an inodorous, colorless gas passes into the air.

The incineration of the body having been effected (which occupies one hour and thirty minutes), the platform is withdrawn from the oven, and all that remains consists of white ashes, mingled with a few pieces of the bones of the head and pelvis, which are friable, and soon become reduced to powder.

From the above description of the Venini Crematory, it might be supposed that it required many and competent persons to work it. But, in a recent communication made to me from Milan, it appears that, to put it in operation, it is simply necessary to open the gas and air valves, as well as those communicating with the canals and chimney, when not any further attention during the act of cremation is called for, the fireman being quite sufficient for all that may be required.

The two systems of Gorini and Venini would appear to differ in many essential points:

1. In the fundamental principle.
2. In the manner of effecting cremation.
3. In the final results obtained.

In the Gorini crematory it appears that there is smoke from the fuel used; smoke from the incombustible carbonaceous human substances, and mixture of vegetable and human ashes; whereas in the Venini crematory there is no smoke from the fuel, nor can any mixture of vegetable and human ashes take place, inasmuch as the former do not exist in the flame poured into the oven from the generator. The cost at the present moment of incinerating a human body at Milan is about fifty francs, while members of the Crematory Society pay two francs a month for one year.

A. B. ARCHBALD.

Florence, October 9, 1880.—*American Register.*

IMPROVEMENT IN TENEMENT LIFE IN NEW YORK.

DURING the last two years the *Evening Post* has had occasion to mention at different times the work done by Mrs. E. F. Miles, in the way of enforcing decency and physical cleanliness among the lowest of the tenement house population in Mulberry, Park, Cherry, Roosevelt, and other streets, whose condition defies description. Mrs. Miles's work was begun, as some of our readers may remember, in 1877, at No. 41 Park street. Long experience had taught this energetic worker that the only way in which very poor and ignorant people can be taught the beauty of order and cleanliness is by personal example and constant watching. The plea invariably put forward by capitalists who own property in these neighborhoods, when blamed for the filthy and degrading condition of their houses, is that even if palaces were built for Italian laborers and rag pickers a week would be sufficient to make pig sties of them. Mrs. Miles dissented from this view. To test the matter she rented the building at No. 51 Park street. The house was of brick, filthy and dilapidated; in the rear was another small building which was rented also so as to have control of the yard. Masons were set at work, the flagging in the yard repaired, the drainage made perfect, the closets cleaned and ventilated, the wood work painted, the walls whitewashed, and the whole place, from the drains under the cellar to the roof, was disinfected and made habitable for decent persons. Then the rooms were offered to tenants at the same rate at which the worst holes in the neighborhood rented; but the understanding on the part of the tenants was that not only the yard, closets, stairs, and hallways must be kept scrupulously clean, but that the rooms must be ready for inspection at all times and kept equally neat; also that no drunkard would be allowed to remain in the house, and no disorderly conduct of any kind tolerated. Several previous attempts of the kind had failed because there was no authority on the part of the missionary to enforce rules. Mrs. Miles could dismiss the incorrigible tenant at three days' notice. At first there was some trouble; people objected to having a visitor come into their rooms at any hour of the day to criticise. But by the summer of 1878 the house in Park street was considered a wonder by the police, house agents, and priests of the neighborhood. Whitewash was found to be a moral agent as well as a physical one; the character of Mrs. Miles's tenants improved steadily.

Property owners in the neighborhood visited the house and were so pleased that in 1878 a gentleman who owned perhaps the worst rookeries in the city, those formerly at Nos. 48 and 50 Mulberry street, offered to tear them down and build model tenements on the site if Mrs. Miles would take charge of them. Mrs. Miles consented, and the rookeries gave place to the substantial four-story brick buildings which for the last two years have been the redeeming feature of that part of Mulberry street. At the time they were opened the *Evening Post* described the rooms and the character of the tenants. It was far easier work to enforce decency in these model buildings than in Park street, for there was every convenience—gas, water, dust shoots, air, and light. The owner was content to receive a small interest on his investment. When the buildings were filled Mrs. Miles appropriated one of the shops on the ground floor as a *crèche* or day nursery, where women with young children could leave them while at work. It was intended at first for the children of the model tenement, but in the end received all who came. This building has now been filled with tenants for two years.

A reporter of the *Evening Post* visited it this morning without giving notice, and found the walls, yards, and stairs as clean as the day it was opened. In the nursery were a score of children, from babies six months old to children of five or six years; all looked happy and contented, some of them sitting at a long low table playing with toys and blocks; others asleep in their cribs; one or two restless infants were rocked by elder children. During the last year the average attendance has been from twenty-five to thirty. When the mothers are able they pay five cents a day for the care and food which each child receives. In many cases the mothers are unable to pay anything, and Mrs. Miles will be glad to have contributions of money and clothing. Many of the little ones are insufficiently clothed. They have to be fed in the nursery, a fire has to be kept up, and the wages of a matron paid. The rooms are given by the owner of the building, who takes a deep interest in the work now permanently established. Visitors are welcome at any time, and will be surprised to find such an oasis in the Mulberry street desert.

When this Mulberry street building was in good order Mrs. Miles declared that she could attend to no more; she made a daily visit to each of her tenants. But other landlords begged so hard that she would do something for their property that her work has grown almost daily. Last January Mrs. Miles undertook the most important work of regeneration with which she has yet been connected. What are known as the Double and Single Allies, at Nos. 36 and 38 Cherry street, have been regarded for years as dens in which even the police scarcely dared to venture after nightfall. "Double Alley" is an alley opening on Cherry street; it is 200 feet long and 10 feet wide, with buildings five stories high on both sides. The Single Alley has a five-story building on one side only. In these two alleys eighty families live, each family occupying two rooms at a monthly rent of four dollars. In January last the alleys were rivers of filth, ashes, and garbage; the closets were pest-holes; the rooms of the tenants were appalling. To-day they were visited and absolutely nothing discreditable was to be seen. Barrels of whitewash have been used, the flagging and drains made perfect, a sewing school for tenants introduced, and a janitor hired. The alleys were as clean as the yard of a Fifth avenue house. In accomplishing this work only eight tenants have been found incorrigible and ordered out. The property pays twenty per centum more now than it did in January.—*N. Y. Evening Post.*

[COUNTRY GENTLEMAN.]

A CHEMICAL VIEW OF ENSILAGE.

THE ensilage of green crops, particularly of maize, has quite recently become the subject of a lively discussion in the agricultural press. On the one hand, many who have experimented with it have reported favorable results, and some of its advocates have extolled it in extravagant terms; on the other hand, many doubts have been expressed as to the practical advantage of the process, and the majority of farmers are doubtless awaiting the results of the experience of the few before venturing upon such a comparatively costly experiment.

In this state of affairs, any light that can be thrown upon the probable advantages, or disadvantages, of ensilage, will doubtless be welcome, and the writer, therefore, proposes to present briefly the results of some experiments made by Moser at the Vienna Experiment Station, an account of which has just appeared in the *Jahresbericht über Agricultur-Chemie* for the year 1879. The purpose of these experiments was to determine the nature and extent of the chemical changes taking place in green maize during its conversion into ensilage, and to ascertain how much material was lost in the process. That chemical considerations such as these are not the *only* considerations to be attended to in forming a judgment on the merits of ensilage, "goes without saying." At the same time the question of the cost of ensilage, as compared with other methods of preserving fodder, can be intelligently discussed only when we know, first, what improvement, if any, it effects in the quality of the fodder, and, second, how much of the improved fodder can be obtained from a given number of pounds of the raw material.

On both these important points Moser's experiments afford us valuable information. They included both the preparation of ensilage proper or "sour maize," in which the fresh maize was cut and packed at once in pits, and that of "brown maize," in which the material was allowed to wilt for a few days before being placed in the pit. It would appear from the description of the resulting fodder that the "brown maize" more closely resembled the ensilage obtained by Goffart in France and Bailey in this country, than the "sour maize" did, but as we shall see the difference between the two is one of degree only and not of kind.

The experiments were made as follows: The composition of the fresh maize was determined by chemical analysis. Bundles of the fresh or wilted plants, weighing 13·2 pounds each, were placed at different depths in pits, and surrounded with cut maize, fresh or wilted as the case may be. The whole was thickly covered with earth, and left to itself until February or March of the following year, when the pits were opened and the bundles taken out, weighed, and analyzed. Each bundle was thus subjected to essentially the same conditions as the surrounding material, and the changes undergone by it show us the character and amount of change taking place in an ordinary silo at the same depth.

QUALITY OF THE FODDER IMPROVED.

Let us first attend to the effect of the treatment which the maize received upon its quality.

The amount of water contained in the several samples varied considerably. Its percentage was generally somewhat less in the ensilage than in the fresh maize, but in some cases it was greater. Since, now, the value of a fodder depends upon the amount of *dry matter* which it contains, and is not sensibly affected by the quantity of the accompany-

ing water, we must leave the latter out of the account in comparing the quality of different feeding stuffs; that is, we must reduce them all to a water-free basis.

The water-free substance of the maize used by Moser, and that of the resulting "sour maize" and "brown maize" had the composition given in the following table. For comparison, similar analyses by Grandeau of fresh maize and ensilage from the farm of M. Goffart are added. Goessmann's recent analyses of ensilage the writer has not yet seen. [*See Table I.*]

TABLE I—COMPOSITION OF WATER-FREE SUBSTANCE.

Description of Sample.	*Albuminoids, per cent.*	*Fat, per cent.*	*Nitrogen, free extract, per ct.*	*Crude fiber, per cent.*	*Ash, per cent.*
Fresh maize.....	4·36	3·68	52·40	32·30	7·26
Sour maize, 17 inches from top of pit.	4·40	4·44	39·21	43·30	8·65
do. 34 do. do.....	4·78	4·87	33·75	46·84	9·76
Br'n maize, 34 do. do.....	5·39	5·71	47·49	34·84	6·57
do. 68 do. do.....	4·44	4·85	49·74	32·60	8·37
Fresh maize (another sample).....	4·21	3·95	52·58	36·08	3·18
Sour maize, 38 inches from top. ...	4·13	5·73	35·00	43·37	11·77
Fresh maize (Grandeau's analyses)..	6·52	1·30	58·71	26·59	6·88
Sour maize do.	6·02	1·92	53·21	26·23	12·02

It will be seen that the quality of the fodder was affected in essentially the same way in every case. The percentage of nitrogen-free extract (sugar, starch, and similar substances) was diminished in some cases very considerably, while that of the other ingredients was increased. The result of such a change in the composition of maize fodder is to *increase its value*, pound for pound, as compared with the original material. Maize fodder is very rich in non-nitrogenous (fat and heat producing) materials, and is deficient in albuminoids. To produce the best results, it must be fed in conjunction with some fodder rich in albuminoids, like oil-cake. Particularly is this the case with maize so unusually poor in albuminoids as that used by Moser, and it is obvious that the "sour maize" and "brown maize" which he prepared from it would require less of such an addition than the fresh maize would, and consequently were more valuable. The same is true, though to a less degree, of the samples analyzed by Grandeau.

In regard to the *digestibility* of ensilage, as compared with that of fresh maize, no experiments have yet been made, though there is no lack of the most positive assertions upon this point. All we can yet say is that numerous experiments on the digestibility of fodder prepared in various ways (including the fermentation of small quantities), have shown that these various modes of preparation are without effect on the digestibility, and that consequently it is most likely that ensilage does not essentially alter the digestibility of maize fodder.

RESULT AS REGARDS QUANTITY.

Let us now inquire *how much* of the improved fodder was obtained in these experiments. The bundles, as put into the pits, weighed 13·20 pounds each. When taken out they had the following weights, as compared with their original weight:

	Fresh, pounds.	Water-free, pounds.
Fresh maize.....	13·20	2·73
Sour maize, 17 inches from top.	4·64	1·97
do. 34 do. do..	8·04	1·78
Brown maize, 34 in. from top.	9·35	2·05
do. 68 do. do..	12·66	2·49
Fresh maize (another sample).	13·20	3·07
Sour maize, 38 in. from top...	10·60	2·05

It appears from these figures that, besides varying amounts of water, the maize lost in the process of ensilage from 8·9 to 34·8 per cent. of its dry matter. Furthermore, the analyses which were made of each sample enable us to ascertain what portion of this loss was borne by each ingredient of the maize. The following statement shows how many pounds of water, albuminoids, etc., were contained in each bundle of the preserved maize, while a simple subtraction from the corresponding amounts in the fresh maize, shows the loss suffered in each case:

TABLE II.

	Water, lb.	*Albuminoids, lb.*	*Fat, lb.*	*Nit., free ext't, lb.*	*Crude fibre, lb.*	*Ash, lb.*
Fresh maize	10·47	0·12	0·10	1·43	0·88	0·20
Sour maize, 17 inches from top.	2·67	0·09	0·09	0·77	0·85	0·17
Loss.....	7·80	0·03	0·01	0·66	0·03	0·03
Sour maize, 34 inches from top.	6·26	0·08	0·09	0·60	0·83	0·18
Loss	4·21	0·04	0·01	0·83	0·05	0·02
Brown maize, 34 in. from top....	7·30	0·11	0·12	0·97	0·71	0·14
Loss.....	3·17	0·01	0·02	0·46	0·17	0·06
Brown maize, 68 in. from top.	10·17	0·11	0·12	1·25	0·81	0·20
Loss.....	0·30	0·01	0 02	0·18	0·07	0·00
Fresh maize..... ...	10·13	0·13	0·12	1·61	1·02	0·19
Sour maize, 38 inches from top.	8·55	0·08	0·12	0·72	0·89	0·24
Loss.....	1·58	0·05	0·00	0·89	0·13	0 05

We learn from this comparison:

1. That, as was to be expected, the fodder dried out considerably in the pit.

2. That the amount of fat and ash remained practically the same, and that only a very small proportion of the crude fiber (cellulose or woody fiber) disappeared.

3. That from 8 to 38 per cent. of the total quantity of albuminoids present, and from 13 to 58 per cent. of the nitrogen-free extract (starch, sugar, etc.,) disappeared during the process of fermentation which the fodder underwent.

This loss, now, of albuminoids and nitrogen-free extract *is the price paid for the improvement in the quality of the fodder which ensilage effects.* That is to say, the loss of non-nitrogenous materials is relatively greater than that of albuminoids, so that what is left must contain relatively more of the latter, and consequently be more valuable, pound for pound, as already explained.

IS THE IMPROVEMENT WORTH ITS COST?

The question now arises, Is the improvement in the quality of the fodder worth the price paid for it? Is it cheaper for the farmer to sacrifice a part of his corn fodder for the sake of having the rest of it of better quality than it is to purchase concentrated fodders, like oil-cake or brewers' grains, to add to the corn fodder in its original state?

It is obvious at once that no one answer to this question can apply to all cases. The prices of concentrated fodders and the cost of raising corn fodder both vary at different times and in different localities, and, moreover, the amount of material lost in ensilage is, as Moser's results show, very different under different conditions. Nevertheless, a few calculations based on one of these experiments may not be uninstructive.

In the sample of brown maize taken 34 inches below the surface, the loss was in the proportion of about 61 pounds of non-nitrogenous matter for every pound of albuminoids; while in the other samples the proportion was about 22 to 1. As a consequence, the improvement in the quality of the fodder was greatest in this case, as is shown by the analysis, while the shrinkage was less than in most of the others.

Here, then, if anywhere in these experiments, we should expect the benefit of ensilage to be manifest.

In this experiment one ton of the fresh maize yielded 1,416¾ pounds of ensilage, containing 16·72 pounds of albuminoids and 273·13 pounds of non-nitrogenous matters. Let us now inquire into the cost of furnishing the same amounts of albuminoids and non-nitrogenous matters by means of a ration having the unaltered corn fodder as its basis. The non-nitrogenous matters of the ensilage would be quite exactly supplied by three-fourths of a ton of the fresh maize, containing 273·75 pounds of non-nitrogenous matters and 13·50 pounds of albuminoids; but there is a deficiency of 3·22 pounds of albuminoids, which may be supplied. This may readily be done by the use of cotton seed meal, for example. To be safe, we will consider only the digestible matters of the latter, which may be estimated with sufficient accuracy for our present purpose at 30 per cent. of albuminoids and 20 per cent. of non-nitrogenous matters. If, then, we add to three-quarters of a ton of the unaltered corn fodder about 11 pounds of average cotton seed meal, costing at present prices about 16 cents, we shall have a mixture fully equivalent to the ensilage from a ton of the same fodder, as the following table shows:

	Albuminoids. Pounds.	Non nitrogenous. Matters—lb.
¾ tons corn fodder.....	13·50	273·75
11 lb. cotton seed meal.....	3·30	3·30
Total.....	16·80	277·05
Ensilage from 1 ton corn fodder.....	16·72	273·13

In a word, the addition of sixteen cents worth of cotton seed meal would make three-fourths of a ton of such corn fodder as Moser's go as far as a ton would when treated by ensilage. The question then becomes simply this: Which is worth most to me, 11 pounds of cotton seed meal or one-quarter ton of corn fodder? This statement assumes that the corn fodder is as digestible as the ensilage, which, as has been said, is probably the case. It is doubtless true that corn fodder would deteriorate somewhat in curing, and be less digestible, but it appears probable that this difference would not be great, and it is at least partially covered by the fact that we have taken account of only the digestible matters of the cotton seed meal.

To what extent are the conclusions drawn from Moser's experiments applicable to other cases? In the first place, as already stated, the experiment on which the above calculations are based is one exceptionally calculated to show the advantages of ensilage. In the second place, while a still greater improvement in the quality of the fodder may sometimes be effected, this can only be done at the expense of a greater loss of valuable substances, while a smaller loss of material will produce but a slight bettering of quality. So, too, a better quality of maize than that used by Moser would yield richer ensilage, but it does not appear likely that the difference between the quality of the ensilage and that of the fresh maize would be very much greater. (Compare Grandeau's analyses.) On the whole, then, it seems highly probable that the general conclusion which we have reached by a consideration of Moser's experiments, will apply also to most, if not all, other cases. That conclusion is, that the addition to maize fodder of a relatively small amount of a nitrogenous food substance, like cotton seed meal, will render it fully equal to ensilage in nutritive value, at comparatively small cost.

In these remarks, the writer has purposely omitted all reference to the expense involved in building silos, cutting and handling the maize, etc. It has been his design simply to show what we can learn from Moser's experiments concerning the losses of material involved in ensilage, and the relative value of the resulting fodder, leaving to those better qualified the decision of the various practical questions of cost, convenience, etc., which arise in connection with this subject.—*H. P. Armsby, Sheffield Scientific School, Nov., 1880.*

AT the last meeting of the French Academy of Science, M. de Lesseps announced that his project for cutting a ship canal across the Isthmus of Panama was, notwithstanding the opposition which it recently encountered in the United States, about to become realized. A syndicate has been formed of the principal financiers of Europe and America to provide the requisite capital, and the great undertaking will be begun forthwith. A bi-monthly bulletin will be issued containing an account of the progress of the work.

RHUBARB CULTURE.

THE culture of rhubarb, or pie plant, is of comparatively recent date. It is said that in 1810, Myatt, a market gardener near London, sent his two sons to market with five bunches of rhubarb, and they could only sell three! At present it has its place in every village garden, and the market gardeners cultivate it by the acre and carry it to mark t by the ton. Its culture, though simple and easy, is not so generally understood as it should be, for it is seldom seen in perfection except in some rich gentleman's garden or in the market gardens near the city; it supplies us with delicious pies and sour sauce at a season when apples are stale, and before ripening strawberries have begun the long list of small fruits which refresh us through the summer.

The soil best suited for rhubarb is a deep, rich, moist loam, well drained, deeply worked, and very heavily manured. For a small garden bed it is usual to spade the land two feet deep, working in a heavy dressing of manure the whole depth. For larger plantations the manure should be deeply plowed in, and a subsoil plow made to follow in the furrow to loosen the subsoil.

The planting is done either in autumn after the October frosts have killed the leaves, or very early in spring, before the buds have leaved out. The old roots are cut into "sets," consisting of one strong bud with a piece of old root attached; these are set one in a place, three feet apart each way, in the furrow of a small plow, and covered with a hoe about an inch deep. The first year after planting the stalks should not be pulled at all, but afterward they will bear pulling quite severely. The after culture consists in hoeing whenever needed to keep down weeds, in cutting off the blossom stems as fast as they appear, since if allowed to grow they weaken the root, and in yearly application of manure, which is best done in autumn after the leaves have fallen; no product of the garden so urgently demands and generously repays heavy manuring; twenty cords per acre every year is none too much; the plow is run lightly between the rows to stir the soil and cover the manure. Rhubarb is sometimes grown from seed, but in this way there is no certainty of obtaining uniform plants; in fact, new varieties are originated by sowing seed and selecting the best of the various resulting seedlings.

The best variety for the family garden is the Linnæus, the best for market is the Victoria. The former is early, less acid, and very tender; the latter enormously large and productive. It is no uncommon thing to see single stems of the Victoria two inches in diameter at the thick end, weighing two pounds, and four feet long. A well dressed piece of rhubarb will yield enormous burdens; twenty to thirty tons to the acre is nothing unusual.

Rhubarb roots soon spread if allowed to stand long in the same place, and the result is a multitude of small stems of inferior character. The remedy is to reset the bed in a new place every six years, or if this can not be easily done, dig out one-half or more of the old crowns with a spade in the autumn or early spring.

Where rhubarb is raised for market the chief labor is the bunching and marketing, and this comes in May when time is valuable for other work; it is, therefore, of first importance to do the work of bunching expeditiously; to this end it is essential to reset or thin out the bed at least as often as mentioned above, and to manure *very heavily*. If the rhubarb is good, three men will easily pull, trim, and bunch a ton in four or five hours; if it is small it will require more than twice as long, and the product will be less desirable when done.

Rhubarb is often forced in winter by digging up the old crowns in fall and placing them in loam under the beds of a greenhouse where the temperature is 40° to 60°; light is not necessary to produce a good result.

A better way is to place a cold frame and glass over a portion of the bed in autumn, and bank up well so as to keep out frost; the glass, if well sheltered with mats and shutters at night, will force a growth in January, so that the frame will need raising by placing on additional planks at each side to carry the glass three feet high from the ground; the stems will soon stretch out so as to touch the glass. It is thus that the skillful Belmont gardeners produce the magnificent forced rhubarb that is to be seen every year in our market in March and April. Forced rhubarb is very tender and delicate, but far less acid than when grown in the open air.—*W. D. Philbrick, in N. E. Farmer.*

CENTRIFUGAL BUTTER MAKING.

AT the recent Southboro session of the Massachusetts State Board of Agriculture, Mr. Burnett gave a short review of the systems in common use, including the old shallow pan method, the deep can, cold water system, and the Ferguson bureau method, and admitted that in good hands excellent results may be obtained by either. Were he to confine his operations to a small dairy, he thought the latter method of setting milk in large pans in an atmosphere controlled in its temperature by the use of ice or heat would be his choice. The centrifugal method is not at present adapted to dairies of less than two hundred cows. Two machines are in use in his dairy at Deerfoot Farm, one that may be run with a continuous stream of milk pouring in, while the cream and skimmed milk are as continuously being drawn off into separate vessels, and another that receives its fill at once, and after being whirled some fifteen or twenty minutes, delivers the separated milk and cream without stopping the machine, and is ready for a new batch. Diagrams on the blackboard were made for illustrating the operation. The milk is poured into a metallic tub which revolves at a speed of many hundred revolutions per minute, and subjecting the contents to a pressure of 200 lb. per square inch, requiring, of course, the very best material for construction. A ten horse power engine is used for driving the machine, but a portion of the power is used in the pole-packing establishment, which is connected with the dairy. The principle involved is as simple as throwing stones and feathers into the air, the heaviest bodies being hurled the farthest and with the greatest force. Skimmed milk being heavier than cream is thrown to the outer portion of the revolving vessel, while the lighter cream remains nearer the center, each portion at the expiration of fifteen minutes being quite separated and standing in two perpendicular walls, both being held down by a cover which projects inward over the milk and cream some six inches toward the center of the tub, or basket, as it is usually called. The skimming is done by inserting the end of a tube into the revolving mass while in motion, the cream being delivered into one vessel and the milk into another. The best success is attained when the milk is at a temperature of about 80°. The capacity of the machine is about 500 lb. of milk per hour, and it is run daily from 8 o'clock in the morning till 2 o'clock in the afternoon, or till all the milk received is

disposed of. Through the past summer some five hundred cows have contributed milk to this establishment.

At this stage of the proceedings, Mr. Bond, one of the inventors of centrifugal machines, came upon the platform with a toy machine intended to show how quickly cream and milk may be separated by this process. Four little glass test tubes were suspended in as many metallic buckets and the machine started, when the tubes almost immediately flew off into a horizontal position, being held by their bails to the center shaft. At the expiration of fifteen minutes of patient work at the crank, which a portion of the time was in the hands of Gov. Long, the milk was found blue and thin in the bottom of the tubes, while the layer of cream, marked by a distinct line of separation, floated on top.

The same principle has been applied for working and moulding butter at Deerfoot Farm with more or less success. Butter taken from the churn and placed in a wire basket is revolved rapidly, and entirely freed from buttermilk. Moulds attached to the outside of the basket are filled with butter ready printed and weighed for market. This is not, however, the usual custom at present, as the machinery has not yet been perfected, but if it should be, dairy hand work would seem to be very nearly at an end.

In response to numerous questions the speaker stated that he does not believe in churning sour cream. Had changed his mind recently on that subject. He uses a common barrel churn, and has his cream at a temperature varying from 54° to 62°, according to the season of the year; uses brine for washing the butter. Has sold his butter fresh from day to day, using but four ounces salt to ten pounds of butter. A sample of forty pounds made to order kept satisfactorily seven months. The melting point of his butter is found to be higher than that of ordinary butter by four degrees. The cream and milk when drawn off enter the tube at a speed equal to 150 feet per minute.

Experiments made in the old country show a gain in quantity of butter from milk handled in this way, from two to five pounds less milk being required for a pound of butter than by other methods. In unfavorable weather the gain may be much more, as there is no loss from the souring of milk before the cream has time to rise. Mr. Burnett had visited Europe the past season, and found some two hundred centrifugal machines used in French dairies, and a few in England. Milk seems to be purified by the process, as there is a thin wall of impure matter found adhering to the sides of the machine after a few hours' use.

VALUE OF ROOTS FOR MILCH COWS.

AT a meeting of the Franklin Farmers' Club, George S. Hancock presented estimates of the value of mangolds for feeding milch cows, and also estimates of the cost of growing these roots. With large, smooth fields, easily cultivated, he had been able to raise at the rate of 1,200 bushels of mangolds per acre, at a cost of $47.75, or less than four cents per bushel. The items charged were as follows:

Plowing and harrowing	$6.00
Eight cords manure at $5 (one-half charged to succeeding crop)	20.00
Carting and spreading	5.00
Planting with seed drill	1.50
Cultivating with horse	1.25
Weeding and hoeing	5.00
Seed, 4 lb	1.00
Interest and taxes	5.00
	$44.75

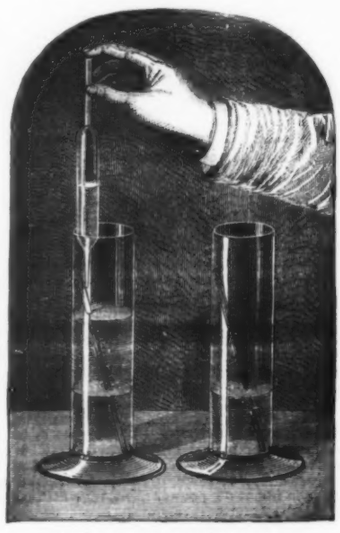
The experiments in feeding were made in winter, when dry hay was the principal feed. In addition to hay, two feeds per day of grain were given to each cow in milk. The feed was a mixture of corn meal and wheat bran, equal parts of each by measure. When no roots were given the grain ration was four quarts at each feeding. When roots were fed, one peck took the place of one grain ration, and it was found that the flow of milk was maintained, but when both grain rations were changed for roots, there was a shrinkage of milk. The experiments were continued for one week with each formula. If the results could be depended upon as a basis for determining values, the roots would be worth twenty-four cents per bushel, as the grain mixture was worth forty-eight cents per bushel at the time of the trials. To determine the value of the roots beyond question, the experiments should be continued for longer periods, and the weight of the animals both at the beginning and end of the trials taken into the account. According to investigations made by chemists, roots are of greatest value when fed in connection with wheat bran, peas, beans, linseed or cotton-seed meal, or other highly nitrogenous foods.—*N. E. Farmer.*

PLANETARY NEBULÆ.

BEFORE the American Association, in Section A, Professor Pickering described the observations of the planetary nebulæ now in progress at the Harvard College observatory. Besides measuring the light of these bodies, the spectrum of each has been examined by inserting a prism between the objective and eye-piece of the large telescope. A star is converted into a colored line of light, but the nebula, being merely monochromatic, appears as a bright point. The difference is so marked that the idea suggested itself that by this means planetary nebulæ might be discovered when disks are so small that they cannot otherwise be distinguished from stars. A search was accordingly undertaken on the evening of July 13, by sweeping or moving the telescope so that a great number of stars could be examined in a short time. In a few minutes such a nebula was found which with an ordinary eye-piece might easily be mistaken for a twelfth magnitude star. A similar object was also detected on the next evening. After this, sweeps on several evenings failed to reveal a single new nebula, although it is estimated that the spectra of 100,000 stars were examined. On night before last, while continuing this work, an object with a remarkable spectrum entered the field. The light appeared to consist mainly of a band in the green, a line in the red, and probably a fainter band in the yellow, the whole being apparently a faint continuous spectrum. The new stars which blazed out in Corona in 1863 and in Cygnus in 1876 presented for a short time a similar spectrum, but with this exception the star referred to appears to be unique. It is too soon to form a theory regarding the nature of this body, as clouds interrupted the observation, and barely allowed time for its identification. It proved to be the star known as Oeltzen 17,681, and must, therefore, have had nearly its present brightness forty years ago. The field for discovery by the method here given is far from being exhausted, since less than one hundredth part of the heavens has as yet been examined.

THE CRYSTALLIZATION OF TIN.

TIN possesses a strong tendency to assume a crystalline form, and this is easily shown by the following experiment, for the description and illustration of which we are indebted to *La Nature*. Make a concentrated solution of protochloride of tin (by dissolving some of the metal in hydrochloric acid), and pour this into a test-glass. Into the solution insert a strip of tin, as shown in the figure to the right. Now carefully cover the surface of the solution with a layer of water. This may be effected without mixing the liquids, by introducing the water by means of a glass pipette



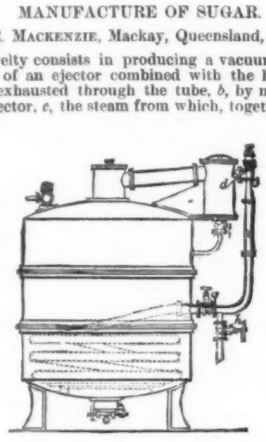
THE TREE OF JUPITER.

—the water being allowed to run in a fine stream down the surface of the strip of metal, as shown in the figure to the left. In a very short time, if the test-glass be left undisturbed, brilliant crystals of metallic tin will be found to have shot out from the strip of metal, and to have assumed a fern-like form. This crystallization takes place only in the layer of water, a fact which is explainable by an electrical action, the details of which it is unnecessary to dwell upon at present. The phenomenon here described is known as the "Tree of Jupiter," tin being called Jupiter.

MANUFACTURE OF SUGAR.

By A. R. MACKENZIE, Mackay, Queensland, Australia.

THE novelty consists in producing a vacuum in the pan by means of an ejector combined with the heating coils. The air is exhausted through the tube, *b*, by means of any suitable ejector, *e*, the steam from which, together with the



heated air, is conducted through a pipe, *e*, into the coils of the pan. A valve, *d*, is provided for, preventing a return current of air to the pan, also valves, *g* and *h*, by means of which the waste steam and air may be diverted direct into the atmosphere.

RIGHTS OF PASSENGERS AT STATIONS.

THE New York Court of Appeals decides that a passenger by railroad has a strict legal right to be run over by the cars, at the depot, if he or she so desires. The particular incident which led to the elucidation of this great principle occurred at Darien, on the Erie Railway, while it was under the charge of somebody whom the law book calls a "Receiver," but who will not receive anything by the judgment in this case; on the contrary, he has to pay $4,000. A young lady arrived at the station, intending to take the cars for Buffalo. Her father accompanied her, and while she visited the passenger room and purchased a ticket, he made inquiries outside as to the arrival of her train. He returned to the sitting room and informed her that it would not arrive for some time; he then bade her good-by and departed, leaving her to find her way to the cars when they should come. When the train was signaled the young lady came forth to take her seat. For some accidental reason the train halted a rod or two before reaching the station, and then started slowly onward again, apparently giving the lady the impression that she must hurry along the tracks and get upon the steps of the car before the train got under headway again. She commenced to do this, and, being flurried by the apparent need of haste, took no notice of a freight train which was "backing and filling" among the complex tracks about the station. By this freight train she was run over and killed, and her father sued for damages. Now, there is a very familiar rule that persons crossing a railroad track are in duty bound to look and listen for any approaching train. If they omit this caution, and are hurt, any lawsuit is at once met by the answer: "It was your own fault," which is always a good defense to a suit for negligence. There are half a dozen decisions to this effect every year. Therefore, although the witnesses testified that the passenger train ought not to have stopped where it did, and that the freight train ought not to have been moving back and forth in the yard at a time when the place was thronged with passengers, yet the railroad Receiver thought he had a clear case. "For," he said, "the lady ought to have looked and listened for the freight train." But the Supreme Court and the Court of Appeals both say, "Not so." The lady was a passenger; she had bought a ticket, and was at the station for the purpose of taking the cars. The fact gave her the right to expect the peculiar care which railroad managers are required to show toward passengers. The rule that a traveler crossing a railroad track is bound to use his eyes and ears to ascertain whether a train is approaching does not apply to a passenger at a station whose purpose in crossing a track is to reach his proper train. The company is bound to furnish to its passengers a safe and convenient access to the cars; if the approach provided involves a passenger's crossing the track, the company must keep the track clear for him to do so. And the passenger has the right to take it for granted that no other train will be run across his path at the particular moment. Therefore, the verdict in favor of the father is sustained.—*New York Times.*

A very similar decision—also against the Receiver of the Erie—was given by the New Jersey Court of Errors two or three years ago.

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